Zion-Mount Carmel Highway
Zion National Park
Springdale vicinity
Washington County
Utah

HAER No. UT-39

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Rocky Mountain Regional Office
National Park Service
Department of the Interior
P.O. Box 25287
Denver, Colorado 80225

HAER
UTAH,
27-SPDA.V,
3-

HISTORIC AMERICAN ENGINEERING RECORD

Zion-Mount Carmel Highway

HAER No. UT-39

Location:	Zion National Park Springdale vicinity, Washington County, Utah
Date of Construction:	1930; Alterations, 1968
Present Owner:	National Park Service U. S. Department of the Interior
Present Use:	Scenic Highway
Significance:	This approximately 10-mile park section of a 25-mile road is of great scenic interest and retains structural integrity. The conception, design and construction of this road was an artistic achievement.
Researcher:	James Jurale September 24, 1984

After four years of planning, construction on Zion-Mount Carmel Highway began in 1927 for the purpose of linking up Zion National Park, Bryce Canyon National Park, Cedar Breaks and the North Rim of the Grand Canyon of the Colorado. Running east from the Virgin River Bridge, the road forms a connecting link between U. S. Highways 9 and 89, and completed the tourist loop envisioned by the Utah Parks Company (UPC) in the early 1920s. The old road network from Zion measured 159 miles to Bryce, 139 miles to Cedar Breaks, and 142 miles to the Grand Canyon. Upon completion in 1930, the Zion-Mount Carmel Highway cut the distance to 88, 70 and 116 miles, respectively. Ironically, this highway promoted the UPC facilitated increased automobile traffic, which eventually took the place of railroad transportation to the parks.

At the time of the dedication ceremony on July 4, 1930, 8-1/2 miles of highway, constructed at a cost of $1,440,000 (including the tunnels) to the Federal Government, were located within the boundaries of Zion National Park. The remaining 16-1/2 miles was a Federal Aid project and had been constructed at the joint expense of the United States and the State of Utah. Thomas H. MacDonald, Chief of the Bureau of Public Roads and his engineering assistants completed the three-year project in 1930. The original reconnaissance was made by U. S. District Engineer, B. J. Finch, and Utah State Engineer H. C. Means, assisted by Zion pioneer rancher, John Winder, Congressman Louis C. Crampton of Michigan, Chairman of the Sub-Committee on Appropriations for National Parks, and Stephen T. Mather, Director of the National Park Service, were instrumental in obtaining the almost $2 million Federal funds.

Presently, the highway extends for approximately 10 miles from the Zion Lodge turnoff to the Park's eastern border, located 1/2 mile beyond the East Entrance Visitor Contact Station. In addition to the Zion-Mount Carmel Tunnel and the Pine Creek Bridge, other manmade structures located on the park portion of the highway include: a 1/10-mile long, rock-faced tunnel located approximately 1.2 miles to the east of the greater tunnel's east entrance; two 20-yard bridges with decorative concrete pylons; numerous galvanized pipe and sandstone culverts; and hundreds of cubic yards of random ashlar masonry retaining walls.

Six switchbacks cut into the soft sandstone of Pine Creek Canyon allow the roadway to drop 800 feet in its 3-1/2 mile course from the west end of the Zion-Mount Carmel Tunnel to the floor of Zion Canyon. The maximum grade is 6 percent. Due to frequent rock falls onto the highway, Civilian Conservation Corps personnel picked loose rocks from the slopes above the highway in the early 1930s. Rock falls are still a road hazard today. Several pulloffs where scenic views may be enjoyed were constructed along the highway in 1968.

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ADDENDUM TO
ZION-MOUNT CARMEL HIGHWAY
Between North Fork Virgin River
and east park boundary
Zion National Park
Springdale vicinity
Washington County
Utah

HAER NO. UT-39

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN ENGINEERING RECORD

ZION-MOUNT CARMEL HIGHWAY
Zion National Park
HAER No. UT-39

This report is an addendum to a ~~10~~ 3-page report previously transmitted to the Library of Congress.

Location:	The approximate 11-mile NPS segment of the 25-mile highway begins within Zion National Park at the west side of the North Fork Virgin River Bridge and runs generally east to the east park boundary. This is a section of State Highway 9, Springdale vicinity, Washington County, Utah to Mt. Carmel vicinity, Kane County, Utah. UTM West terminus: 12/324740/4120600 USGS Quad: Springdale East, UT UTM East terminus: 12/340760/4122420 USGS Quad: The Barracks, UT
Dates of Construction:	1927-1930
Type of Structure:	Vehicular highway
Use:	Vehicular highway
Designer/Engineer:	U.S. Department of Agriculture, Bureau of Public Roads; State of Utah Road Commission; NPS Branch of Plans and Design.
Builders:	Nevada Contracting Co., Fallon, Nevada. Reynolds-Ely Construction Co., Springville UT Raleigh-Lang Construction Co., Springville UT
Owner:	National Park Service
Significance:	The highway is an early representation of NPS and BPR national park road building, featuring scenic vistas, easy grades, minimal landscape marring in mountainous terrain, and rustic style amenities. One of the most expensive segments of road built by the NPS at its completion, it contains significant features such as the lower Pine Creek Bridge and Zion Tunnel.
Project Information:	Documentation of the Zion-Mount Carmel Highway is part of the NPS Roads and Bridges Recording Project, conducted in the summer of

1993 under the co-sponsorship of Zion National Park and HABS/HAER.

Michael F. Anderson, HAER Historian, August, 1993.

INTRODUCTION

The 25-mile long Zion-Mount Carmel Highway connects southern Utah's principal north-south transportation arteries, Interstate 15 and Highway 89. Completed in 1930, it immediately served a number of regional transportation needs, including an all-weather road from Kane County and other points east of the Wasatch mountain range to the nearest railhead at Cedar City, and a well-graded modern highway for the growing number of tourists to southern Utah. The 11-mile segment considered in this report is that portion which lies within the bounds of Zion National Park, created by act of Congress in November 1919. This highway segment offers access to the park from the east and provides scenic vistas through the plateau slickrock country and of Pine Creek Canyon along the lower switchbacks.

HISTORICAL CONTEXT

Popular needs and demands for better east-west transportation in southern Utah lagged fifty years behind the earliest settlement in the region. Mormon colonizers migrating south from Salt Lake City had settled the Virgin River Valley and Zion Canyon by the early 1860s, but for several generations had more pressing concerns than construction of a road to the east. Cattle ranching and subsistence farming in the semiarid high desert region kept the settlers busy close to home, while trade and communication typically led west and north whence the pioneers had come: to the string of towns connecting the western boundary of the Mormon State of Deseret.

By the turn of the twentieth century, local citizens of Rockville and Springdale immediately west of Zion Canyon had satisfied their few needs for access to the high plateau country. John Winder, a settler in the region since the 1880s, had improved an old Southern Paiute trail to the east rim which served cattlemen as well as operators of the Zion cableworks--the astonishing aerial tramway built in 1901 to transport lumber from the rim to the valley below. The road leading to the base of this trail at the lower cableworks (today's Weeping Rock area) was little more than a set of wagon ruts to be sure, but sufficed for driving cattle between summer and winter ranges and for moving lumber and supplies to and from the cable system.

Demands for better roads, not only in the Zion region but everywhere in the United States, awaited the dawn of the automobile age. As the nation awoke to the scenic splendors of the American West and coincidentally fell in love with the

automobile, motor enthusiasts lobbied in varied ways for better conduits to the national parks and forests. Motorists and businessmen alert to the possibilities of tourism first raised the cry in southwestern Utah in the 1910s, and it was not long before the State of Utah and the federal government responded with a decades-long program to improve transportation to and within Zion National Park.

A number of factors combined by 1920 to argue for a road passing through Zion National Park and connecting Highway 91--the "Arrowhead Trail"--25 miles to the west with Highway 89 equidistant to the east. Population and business growth in Kane County argued for an all-season, all-weather road across the north-south mountain range (the Hurricane Fault region) to the nearest railhead at Cedar City, Utah. Development of local scenic wonders--Zion, Cedar Breaks, Bryce, and North Rim of the Grand Canyon--and the emergence of a "Grand Circle" tourism route which connected the nascent parks suggested a shorter more scenic vacation if a road could be built through Zion. These factors, and a growing desire among locals for tourist dollars, led to the location, survey, and construction of the Zion-Mount Carmel Highway in the years 1923-1930.

HISTORY OF THE STRUCTURE

Location and Survey

The location of that road hinged on one major question: how could it ascend from Zion Canyon to the plateaus far above? This was the principal conundrum facing B. J. Finch, District Engineer for the Bureau of Public Roads (BPR), and Howard Means, Chief Engineer for the Utah State Road Commission, when they travelled to Zion in 1923 to reconnoiter the area for a highway route. These men joined with John Winder to explore the near wilderness east and west of Zion Canyon in the hope of finding a practical ascent. Ultimately, they determined the best route would proceed from the mouth of Pine Creek and climb to the 100' fall adjacent to the Great Arch of Zion. They considered and rejected the idea of tunneling through the arch and imagined, rather, a half tunnel astride or full tunnel within the face of the Navajo sandstone cliff on the south side of the creek.[1]

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[1] R. R. Mitchell, Associate Highway Engineer, "Location Report, Zion Park-Mt. Carmel Road: Zion Park Section," 1926, Zion Tunnel & Roads Reports File, Park Administrator's vault, Zion National Park (ZNP); Donald T. Garate, "The Zion Tunnel: From Slickrock to Switchback," manuscript, Zion Natural History

Finch returned in August 1925 with R. R. Mitchell, BPR Associate Highway Engineer, for further reconnaissance of the general highway route. In October, Mitchell, along with Senior Highway Draftsman K. B. Campbell and Transitman T. A. Jones, returned to Zion Canyon for a formal location. These men spent over two months (through December) exploring Pine Creek and the slickrock country east to Mt. Carmel. Difficulties with the terrain required the men to blast a 100' trail along the side of a cliff to carry the location above the 100' fall near the Great Arch, and transport of supplies up to the east rim with an improvised cable system.[2]

Since no topographical maps existed for Zion National Park, Mitchell's party used direct location to sketch out a broad route which would later be followed, that is, up Pine Creek and above to the eastern slickrock country then out the drainage of Clear Creek to the comparatively level plateau. Their more specific location, however, proposed starting at the existing Virgin River Bridge 1000' upstream of the old south entrance checking station, thence around and up the talus slope north of Pine Creek to the base of the Great Arch. Here the road would cross to the south side of the creek and ascend the 100' fall through a spiral tunnel (something Finch and Means had rejected earlier), thence up the north side of Clear Creek through a series of five short tunnels to the park's east boundary at the Kane County line. Mitchell suggested using switchbacks with curve radii as tight as 80', grades of up to 8 percent, and a rather torturous ascent of the final cliff out of the canyon.[3] This location would later be rejected.

Association (ZNHA) files, ZNP; "Autobiography of Howard Means," manuscript, history boxes, ZNP library.

Donald Garate's manuscript was edited and published as The Zion Tunnel: From Slickrock to Switchback (Zion Natural History Association, 1991, Revised edition). The 52-page booklet is excellent for reproductions of historical photographs, informative photo captions, and road statistics, but lacks the detail of the author's manuscript, thus, the latter is used as a principal source.

[2] Mitchell, "Location Report"; ZNP Superintendent's Annual Report, 1925, Zion Codex, ZNP Library.

[3] Mitchell, "Location Report."

While Mitchell and his men scrambled about the slickrock country above Pine Creek, local agitation arose over other possible routes to accomplish regional transportation goals. One alternative which deserved more consideration than it received involved the improvement of the recently bridged and graded "Rockville shortcut," which ran from the Town of Rockville to the west of Smithsonian Butte and on to a connection with the (poor) road to Pipe Spring National Monument and Fredonia, Arizona. R. A. Brown, highway engineer for the Bureau of Public Roads, noted in 1931 that this route (and others later rejected) was impracticable, yet the road existed and only required further grade and surface improvements to make it a first class road, at low cost, and at a lower elevation than the proposed Pine Creek route. Since the National Park Service had only the year before expended $40,000 to build the Rockville bridge, and in 1925 improved the road (with cash assistance from Stephen Mather), this choice was clearly the most economical and would have proved to be the easiest to maintain over the years. Other alternatives rejected out of hand included construction of a road from the Town of Virgin up North Creek to the north rim of Zion Canyon thence across the North Fork of the Virgin River to the east rim, and a road up Shunesburg Canyon near Springdale.[4]

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[4] R. A. Brown, Final Construction Report on East Rim Road Route #1," manuscript, 1931, Zion Tunnel and Road Reports File, ZNP, 7-8. Brown's completion report is a marvel of historical detail and was used as the primary document in writing this history of the Zion-Mount Carmel Road. The report includes final inspection reports detailing change orders, as well as final financial statements and construction photographs. This report along with reports by Mitchell and Davis on location and supplemental construction may have once resided at the NPS technical center in Denver, as cited by Garate in his manuscript, but were sent to Zion NP about 1990 and now reside in the park administrator's vault. See also Guy D. Edwards, "Engineering Activities at Zion National Park," 10 January 1928, history boxes, ZNP Archives, 2; and Harry Slattery, Secretary of the Interior, to the United States Senate, letter, 10 November 1938, Zion Codex, ZNP.

The Rockville Shortcut road and bridge--which today form a Utah "scenic backway" maintained by Washington County--are discussed in the context of tourism in the historical overview. It is interesting to note here that advocates of the Pine Creek route in the middle 1920s did not emphasize their desire to create a scenic highway to open up new park vistas. Rather, they tended to emphasize "practical" motivations and disparage other routes

Still another alternative which challenged the Pine Creek path was one that would run up Parunuweap Canyon from the Springdale/ Rockville area and out to the east rim. This route was roughly parallel to that of Pine Creek. It followed an old Indian path up the East Fork of the Virgin River and was used by pioneers as a mail trail to Fredonia and Kanab, but no "road" had ever been built. R. R. Mitchell's assessment of this route in 1925 was unfavorable, yet no one was happy with the location Mitchell had made of the Pine Creek road either, so new locations and surveys of both routes were undertaken in 1926. The resultant estimates were so close that both locations went through the design phase in early 1927. Designs revealed that the Parunuweap would be shorter by nearly two miles, contain only half the distance of grades greater than 4 percent as the Pine Creek route, attain an elevation 500' lower, and overall decrease travelling distance to other parks in the "Grand Circle" as many miles as the Pine Creek route. Pine Creek won out, however, since it required 2,300' less tunnel and would cost an estimated $1,481,070, approximately $400,000 less than a Parunuweap road.[5]

In February 1927, BPR district personnel completed plans, specifications, and estimates for the Pine Creek route, separated the overall project into three sections, and by August began restaking centerline for Section 1, which would begin at the south checking station (Station 273+50) and extend 3.6 miles to the proposed west portal of the tunnel (Station 77+25). Staking was completed by Brown, Jones, and rodmen Ben Lee and Steve Jennings (these same men did the engineering work for Section 2). This first section of road as resurveyed in 1926 would run up the north side of Pine Creek, bridge the creek half a mile from its mouth, and continue up the south talus slope in a series of switchbacks--seven lines in all with radii varying from 100'-170'. It would gain 800 vertical feet in elevation from Pine Creek to the tunnel's west portal within a rectangular area one mile long and 1/4 mile wide. Plans called for a standard 16'

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for reasons that ring a bit false. The author has considered the alternatives at length and concludes that an improved Rockville shortcut road would have been the cheapest to build, cheapest to maintain, most practical all weather route, and would have kept Pipe Springs within the Grand Circle tourism route. See Dorr G. Yeager, "Comments on the Impairment of Park Values in Zion National Park," manuscript, 23 March 1944, copy in Memorandum for the Director Folder, history boxes, ZNP Archives, 4-5, for agreement on this opinion.

[5] Brown, "Final Construction Report," 8-9.

oil-mixed gravel roadway with masonry retaining walls and guardrails as required. The only deviation to this design during construction would be postponement of guardrails and some retaining walls, and slight line changes as crews encountered difficulties with terrain and soil composition.[6]

The tunnel was designated as Section 2, which would run from Station 77+25 at its west portal to Station 20+80 at its east portal. The BPR completed contour maps of the cliff face in May, which revealed a surface much too irregular and unstable for an exterior half tunnel, but confirmed that a tunnel was possible within the cliff face which would require no more than a 5 percent grade to gain the east rim. They also determined that galleries venting to the outside of the cliff would be required, and chose points 750, 1452, 2752, 4047, and 4745 feet east of the proposed west portal--locations providing concave surfaces and the most available light (a later gallery would be added to the design: Gallery 6, some 518' east of the west portal). They would bore the tunnel in a series of tangents between these galleries with transitional curves at the openings. Plans called for a 20', concrete-surfaced roadway with an 11' clearance at spring line and 16' ceiling. This design also was achieved in construction, with major changes limited to more timber and concrete support linings than originally envisioned.[7]

Junior Highway Engineer F. LeRoy Davis supervised the detailed survey and staking of Section 3, which continued from the tunnel's east portal (designated Station 199+40 for purposes of measuring eastward) to the east park boundary (Station 387+46.8) and followed closely the location recommended by Mitchell in 1925. The road would follow the north side of Clear Creek Canyon and the principal difficulties would be spanning the numerous drainages and balancing the cut and fills in the jumbled slickrock terrain. Davis laid out five small tunnel sites initially, but four of these were later replaced by steeper grades and deeper cuts. He avoided the use of switchbacks, but staked a curvilinear alignment with varied types of fill-covered culverts and water tunnels spanning the many intermittent-flow side drainages. Specifications dictated a standard 16' roadway of lightly-oiled "selected materials."[8]

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[6] Brown, "Final Construction Report," 11, 44.

[7] Brown, "Final Construction Report," 12-13, 44.

[8] Brown, "Final Construction Report," 11-13, 44.

Construction

Three conditions--one political, one aesthetic, and one physical--would combine with engineers' specifications to dictate construction of the Zion-Mount Carmel Highway. The political condition stemmed from an intricate agreement between the Union Pacific Railroad, United States Congress, State of Utah, and National Park Service concerning the designation of nearby Bryce Canyon as a national park. Summarily, Congress would not allow Bryce's promotion from monument to park status unless the NPS eliminated its inholdings; the Union Pacific bought the inholdings, but would not give them up unless an east-west road was built providing better visitor access to the park within three years; the NPS and state agreed to fulfill that travel need with the proposed highway and to complete it within the railroad's timetable. Thus, a three-year construction schedule was mandatory, and a late finish could produce more embarrassing consequences than the run-of-the-mill late project.[9]

The aesthetic condition centered on National Park Service landscape requirements. Since 1918, the NPS had insisted on aesthetic consideration within all proposed national park highway projects. Since 1918, it had maintained a landscape engineering division and required that all major construction specifications be reviewed and all projects inspected to ensure that the natural environment was disturbed as slightly as possible.[10] At Zion

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[9] Brown, "Final Construction Report," 14; Garate, "The Zion Tunnel," 16-17; Yeager, "Comments on the Impairment of Park Values," 5. Note that Bryce was promoted to park status in 1928 while the Zion-Mount Carmel Highway was under construction. The Union Pacific fulfilled its promises early and trusted that the BPR and NPS would complete the road as they had promised.

[10] Stephen T. Mather, "Engineering Applied to National Parks," American Society of Civil Engineers Transactions, Paper No. 1754, circa 1930, copy in Miscellaneous File, history boxes, ZNP Archives; Horace M. Albright, The Birth of the National Park Service:The Founding Years, 1913-1933 (Salt Lake City: Howe Brothers, 1985), 70, 103; Hubert Work, Secretary of the Interior, to the Director, memorandum, 11 March 1925, Miscellaneous File, history boxes, ZNP Archives.

The policy of using landscape architects to help design roads began with a memorandum from Secretary of the Interior Franklin Lane in 1918, was formalized by Mather in 1918 with the creation

National Park, Associate Landscape Engineer Thomas C. Vint inspected the proposed route in February 1927, and once earlier, to approve the route from an aesthetic perspective. Assistant Landscape Engineer Harry Langley would be closely involved with construction in the following years. They wrote a number of restrictive requirements into the specifications which would require contractors to exercise caution in their work and forego construction efficiencies to preserve the landscape.[11]

The physical condition was simply one of inaccessibility of the highway route except at the very starting point at the Virgin River. A long series of locators and surveyors had experienced severe difficulties taking measurements along the way since the only road or trail even approaching the national park segment of the project was the Zion Canyon access road from Springdale. Nothing resembling a road approached the project site from the east. With inaccessibility added to the political timetable and aesthetic admonitions, contractors would hardly know where to move an air shovel, but knew they would have to move it quickly or face penalties.

These conditions dictated how the BPR laid out construction schedules and the order in which they let various contracts. Simultaneous construction of varied sections was necessary, and posed certain difficulties, since there was no way to approach the tunnel site until a pioneer trail or road could be completed from above or below (and that trail would have to follow the eventual road grade to avoid marring the landscape). On Sections 1 and 2, for example, strategies required by contract conditions would include an inconspicuous trail from Pine Creek to the base of the cliffs, the opening of multiple galleries in the cliff face and tunneling in both directions from each gallery, the driving of a pioneer tunnel followed closely by tunnel enlargement, establishment of a construction camp half way up the talus slope to accommodate work on both sections, construction of a tram from Pine Creek to the camp to move heavy equipment (since there was no road at the start), and the employment of other time

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of the NPS landscape engineering division and has remained in effect ever since.

For Mather's own interpretation of the NPS landscape engineering policy, see Stephen Mather to Walter Ruesch, letter, 10 January 1922, Miscellaneous File, history boxes, ZNP Archives.

[11] Brown, "Final Construction Report," 19; Thomas C. Vint to the Director, letter, 2 February 1927, Zion Codex, ZNP Library.

and landscape-saving efficiencies that would have been unnecessary had the contractors been allowed to start from Pine Creek and simply move forward.[12]

The BPR began to advertise contracts 2 August 1927. The first contract called for construction of Section 2, the Zion-Mount Carmel Highway Tunnel (except for its paving, gunite lining, and tunnel portal), as well as Section 1 grading, graveling, and minor structures. The BPR opened bids 31 August 1927, and recommended the contract be awarded to the Nevada Contracting Company of Fallon, Nevada, for the low bid of $607,058. The Secretary of the Interior approved the contract 7 September and planning for simultaneous construction of both sections began 13 September 1927.[13]

The second contract advertised 30 July 1928, called for construction of Section 1 bridges, that is, a new North Fork Virgin River bridge near the start of the highway project and a bridge spanning Pine Creek approximately .6 miles from its mouth (See HAER Reports No. UT-39-B and No. UT-39-C). The Secretary of the Interior rejected all bids because the engineer's estimate suggested a cost of $174,290.50 while the low bidder, C. F. Dinsmore of Ogden, Utah, bid $180,731. The BPR and landscape architects spent nearly a year arguing bridge requirements and redesigning the structures before bids were again advertised on 23 July 1929. The Reynolds-Ely Construction Company of Springville, Utah, won the contract for the redesigned bridges and other minor road work on 30 August 1929, for the low bid of $136,918.12.[14]

The third contract went out to bid 8 September 1928, and called for grading and structures on Section 3. The Nevada Contracting Company was awarded the contract 9 October 1928 for the low bid of $315,906.40. On 11 May 1929, requests for bids went out for the fourth contract for tunnel paving, gunite lining, oil-mixed gravel for Section 1 roadway, and miscellaneous items, which the Nevada Contracting Company also won for the low bid of $136,918.12. A final contract for surfacing of Section 3 was

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[12] Brown, "Final Construction Report," 14, 19-23.

[13] Brown, "Final Construction Report," 15, 18.

[14] Brown, "Final Construction Report," 16-17. The delay in getting out this contract was one of the reasons why the bridges were not completed until after the formal road dedication of 4 July 1930.

awarded to Ora Bundy of Ogden, Utah, for the (sole) bid of $20,955.[15] All initial contracts totalled $1,237,306.52 for the approximate 8.5 miles of road and tunnel construction from the south checking station (in 1928, just a few hundred feet west of today's North Fork Virgin River Bridge) to the east boundary of the park. Change orders would later bring the contract price to nearly $1,500,000 for 8.5 miles of roadway, the most expensive piece of roadwork yet undertaken by the NPS.[16]

Specifications called for completion of Sections 1 and 2 within 325 calendar days, thus, the Nevada Contracting Company had to move equipment to the tunnel site immediately to accommodate simultaneous construction on both sections. One of the first activities required extension of a two-year old trail from the mouth of Pine Creek to Station 171. Crews extended the trail to the site of the proposed contractor's camp in late October 1927 and used it to move equipment and supplies to the camp until the completion of an aerial tram. Trail crews continued steeply up the talus slope from the camp site to the base of the cliffs below the sites of Galleries 6 and 1, and as the project progressed, to the sites of Galleries 2, 3,and 4. They completed the final segment--a perilous, narrow ledge along the cliff to Gallery 4--on 18 February 1928. Men used the pioneer trail until July when tunnel pilot bore crews reached Gallery 4.[17] Portions of the narrow, hastily-constructed path can still be followed to the site of the early compressor plant above Station 115 and along the slope beneath the cliffs at least as far as Gallery 3. Along the trail, one finds fragments of narrow gauge rails used by mining cars during pilot bore operations and segments of the 5" compressed air lines, as well as tourist debris tossed from the galleries over the past 63 years. Rockslides have obliterated much of the trail, however.[18]

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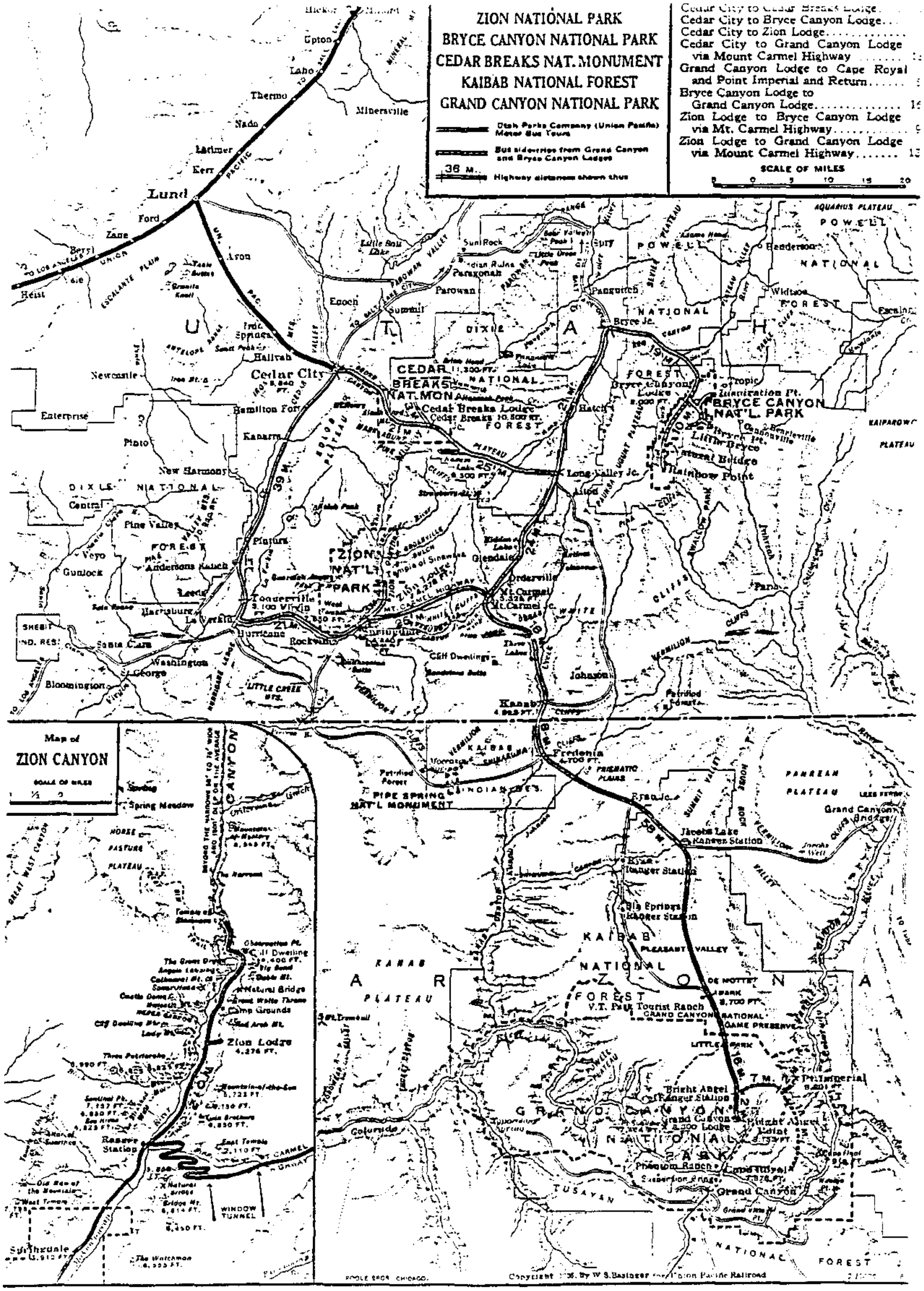
[15] Brown, "Final Construction Report," 17-18.

[16] Garate, "The Zion Tunnel," 14f.

[17] Brown, "Final Construction Report," 22-23.

[18] Field observations, 14 June 1993. The trail can be accessed by following a more recent path ascending south from the Nevada Switchback and maintaining a level consistent with reaching the base of galleries 1 and 6. The compressor site is marked by a small flat area beside the cliff with a metal bar lodged in its side. Other construction signs include holes and bars in the cliff face beside the first few galleries, used to support scaffolding and ladders to the gallery sites.


ZION NATIONAL PARK
BRYCE CANYON NATIONAL PARK
CEDAR BREAKS NAT. MONUMENT
KAIBAB NATIONAL FOREST
GRAND CANYON NATIONAL PARK
Utah Parks Company (Union Pacific) Motor Bus Tours
Bus sidetrips from Grand Canyon and Bryce Canyon Lodges
36 M.
Highway distances shown thus
Cedar City to Bryce Canyon Lodge
Cedar City to Zion Lodge
Cedar City to Grand Canyon Lodge via Mount Carmel Highway
Grand Canyon Lodge to Cape Royal and Point Imperial and Return
Bryce Canyon Lodge to Grand Canyon Lodge
Zion Lodge to Bryce Canyon Lodge via Mt. Carmel Highway
Zion Lodge to Grand Canyon Lodge via Mount Carmel Highway
SCALE OF MILES
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Map of
ZION CANYON
Lund
Cedar City
CEDAR BREAKS NAT. MON.
Cedar Breaks Lodge
BRYCE CANYON NAT'L PARK
Bryce Canyon Lodge
ZION NAT'L PARK
Zion Lodge
Long Valley Jc.
Mt. Carmel
Kanab
Fredonia
PIPE SPRING NAT'L MONUMENT
Jacobs Lake
Kanab Plateau
Grand Canyon Lodge
Bright Angel Point
Point Imperial
Cape Royal
Zion Lodge 4,276 FT.
WINDOW TUNNEL
Copyright 1936, By W. S. Baslozer for Union Pacific Railroad
POOLE BROS. CHICAGO

The contractor completed an aerial tramway from the north side of Pine Creek--northeast of Station 240 and the proposed Pine Creek Bridge--to the Sandwich Rock switchback near Station 147 on 22 November 1927. The tram, approximately 1200' in length to gain 400 vertical feet, supplied all manner of equipment and supplies to the construction camp between that date and September 1928. Its completion allowed the camp to be built atop the roughly 7-8 acre bench found along the upslope of Stations 130-140. Slight ruins of the cable's base are found today atop the Springdale cliff formation, approximately 200 yards northeast of the Pine Creek Bridge.[19]

The construction camp formed the hub of every day work and life for Section 1 and 2 work crews and their families. Ultimately, it would contain sixteen 14'x16' "box car" buildings used as bunk houses for the single men and twelve 14'x16' cabins which served as living quarters for the married men and their families. Other structures included tents for more housing and miscellaneous needs, a cook shack, blacksmith shop, and garage. The camp also supported a cobbler and several amateur barbers, a doctor (Clark McIntire from Kanab, Utah), and camp commissary. When the camp was completed 9 December 1927, more than 100 men who had been temporarily housed at the Union Pacific utility camp (the old Wylie tourist camp) in Zion Canyon moved up to join the tunnel construction crews already living at the site.[20]

Camp life for the next couple years consisted of a continuous traffic of crews moving to and from work sites amidst the incessant dust and noise of dynamite blasts. The cook and his helpers served meals at 6:00 a.m., noon, and 6:00 p.m., and made sack meals for crews working all hours of the day and night. Men and families tried to work, eat, and sleep under these conditions. Some carried cots to the cliffs beneath the tunnel to escape the heat and bustle of camp life and catch a little sleep. Children attended school in Springdale. One winter the children's routine consisted of riding a bobsled down the pioneer

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[19] Brown, "Final Construction Report," 23; Garate, "The Zion Tunnel," 19; field observations, 19 July 1993. The tram site is identified today atop the Springdale formation NNE of the Pine Creek Bridge. Only the ends of two 6-strand cables and some timber--partially buried by rocks--remain of the once busy site. Garate notesthe system required a 50' vertical lift to bring equipment and supplies to the tram cable from the canyon floor.

[20] Garate, "The Zion Tunnel," 20-22; Brown, "Final Construction Report," 24.

road to its base, catching a ride into town for school in a passing automobile, then returning to camp in one of the Mack trucks. Adults found entertainment in dances and other social events in Springdale; some, in bootleg alcohol from local suppliers. All obtained room and board from the contractor, who charged $1 per day for three meals and a bunk and deducted the amount from paychecks. For some unskilled laborers, this amount represented about 50 percent of their earnings.[21]

While these preliminary activities were underway, road construction began 27 September 1927, when Section 1 Superintendent Stanley Bray started six men to work clearing brush on the right-of-way along Pine Creek. On 8 October, operators of a 1-1/4 yard P.& H. Shovel began construction of the pioneer road from the south checking station and moved ahead with two crews working 8:00 a.m. to 3:00 a.m. daily. By 13 November, men working a 3/4 ton P. & H. Shovel began taking the road out to finished lines and grades and 59 men were at work on Section 1. By 6 December, a third P. & H. Shovel was brought on-site to help widen the road to specifications, men had pushed the pioneer road as far as Station 160, and 110 men were at work on this section. Work continued in this manner until the contractor completed the pioneer road to the tunnel's west portal 9 February 1928--four days before miners working the tunnel pilot bore blasted out the portal itself. Men finished the Section 1 rough grading 28 July 1928, at which time crews began to finish the road and apply a red clay surfacing to the subgrade (which served as a wearing surface for more than a year). Despite problems coordinating the activities of the three shovels, numerous breakdowns, and sandy soil impeding the use of the shovels equipped with solid tires (replaced later by dual pneumatic tires) the contractor completed project requirements for Section 1 on 27 October 1928.[22]

Section 1 construction problems included the sandy soil of the talus slopes, a scarcity of suitable rock for retaining walls, and the care required to avoid scarring the landscape. Only boulders lying in the direct line of the road or those found in nearby gullies could be used, as removal of the abundant rock elsewhere would have marred the landscape. Blasting crews also had to take care that boulders were not sent crashing down the steep slopes destroying vegetation (and people) along the way. One such boulder actually killed a shovel operator, Mac McClain,

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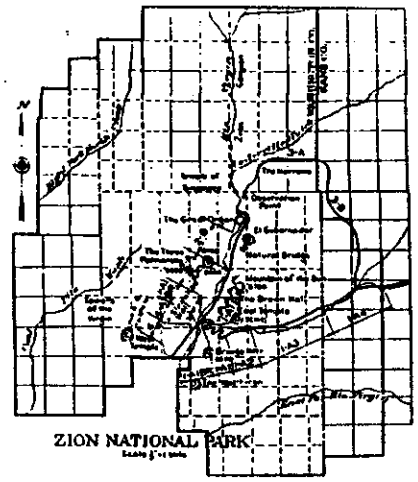
[21] Garate, "The Zion Tunnel," 20-22.

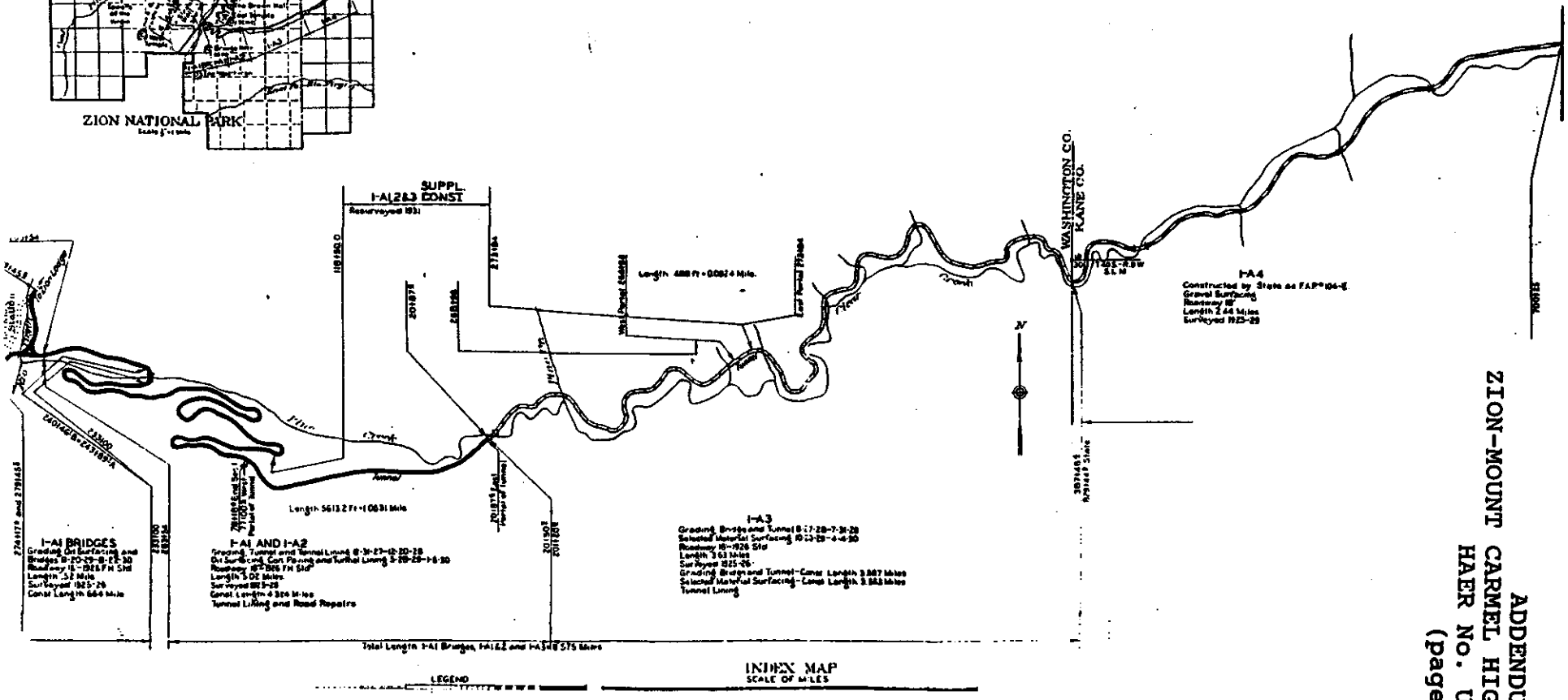
[22] Brown, "Final Construction Report," 24-26; Garate, "The Zion Tunnel," 30.

NATIONAL PARK SERVICE

PLANS FOR PROPOSED
PROJECT I-A1,2&3 SUPPLEMENTAL CONSTRUCTION
ROUTE NO. 1~EAST RIM ROAD
ZION NATIONAL PARK
HIGHWAY SYSTEM
UTAH

INDEX TO SHEETS			
Sheet No.	Description	Stations to Stations	
1	Title		
2	Layout	"	"
3	Plan	771+00.0	881+50.0
4	Gallery #1		
5	Gallery #2		
6	Gallery #3		
7	G-12-L Drawing		





ADDENDUM TO
ZION-MOUNT CARMEL HIGHWAY
HAER No. UT-39
(page 19)

when it pinned him against the tracks of his shovel. Because the slope promised to settle over an extended period of time, the contractor postponed gravel surfacing until later in the project, and the BPR delayed building guardrails--except those placed atop the retaining walls--until a later contract. Sandy soil required many slight changes to the road line to maintain balance and to prevent the tops of the upper cut slopes from intersecting the toes of the embankment slopes. Sandy soil also necessitated the red clay surface applied to the subgrade to minimize ravelling and sliding of the cut banks. Despite these problems, crews adjusted and maintained the designed grades, and the contractor managed to realize a $9,000 profit (3 percent) on expenditures of $303,000.[23]

Stabilizing the cuts presented one of the more difficult tasks during switchback construction. The road commonly slid down the slope overnight once crews removed rock and sand to build the next line. The Nevada Switchback exhibited this tendency more than others and required the removal of thousands of tons of sand and boulders, some the size of small buildings. To stabilize the slopes men built masonry retaining walls in the steepest places, using sandstone blocks obtained from nearby gullies and from a quarry between the park boundary and Springdale. Shea and Shea subcontracted for this work and kept many local men and wagon teams busy chiseling and transporting the rock to building sites. Locals John and Howard Ruesch directed most of the masonry work, which included a swinging boom derrick to move blocks to the wall tops.[24] The results of that work are visible today in the many segments of fine, downslope masonry walls and one short segment of breast wall ascending the switchbacks.

Work on Section 2, the tunnel, began 23 October 1927, when construction superintendent R. N. Scott and 16 men began the pioneer trail from Station 170 to the cliffs beneath the tunnel site.[25] Crews housed at the construction camp worked independently and simultaneously on Sections 1 and 2 as planned. Specifics of tunnel construction are described in another report

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[23] Brown, "Final Construction Report," 26-29, 34; Garate, "The Zion Tunnel," 31.

[24] Garate, "The Zion Tunnel," 31-32.

[25] Brown, "Final Construction Report," 29.

(see HAER UT-39-A) but, summarily, these are the major dates at various points in the Section 2 project:[26]

31 October 1927:	Completion of trail to Galleries 6 and 1.
8 November:	First hole drilled at Gallery 1.
14 November:	First hole drilled at Gallery 6.
3 December:	Thirty-five men engaged in tunnel work.
19 December:	Tunneling begins between Galleries 6 and 1.
19 December:	Tunneling begins between Gallery 6 and west portal site.
3 January 1928:	Electricity from Dixie Power Company at LaVerkin arrives at tunnel site, allowing night lighting and use of Sullivan stationary compressors and Butler mucking machine.
18 January:	Pilot bore complete between Galleries 6 and 1; pilot tunnel drift starts east from Gallery 1, and east and west from Gallery 2.
18 February:	Ring drilling the main bore begins between Gallery 6 and the west portal.
19 February:	Pilot tunnel drift begins east and west of Gallery 3.
25 February:	Timber lining operations begin from west portal (change order required).
1 March:	Second Sullivan stationary compressor in operation and Erie air shovel begins taking out main bore muck at west portal.
6 March:	Pilot tunnel completed between Galleries 1 and 2.
15 April:	Pilot tunnel completed between Galleries 2 and 3.
5 May:	200' stope completed to drill Gallery 4.
14 May:	Gallery 4 blasted out from inside.
23-25 May:	Pilot tunnel drift begins east and west of Gallery 4.
1 July:	Pilot tunnel completed between Galleries 3 and 4.
5 August:	Gallery 5 blasted out from inside.
16 September:	Pilot tunnel holed through east portal; pilot tunnel complete.
19 October:	Ring drilling completed to east portal; main bore complete.
19 December:	Trimming up and shooting tight places complete.
20 December 1928:	Section 2 project recommended for acceptance

[26] Brown, "Final Construction Report," 29-34.

While crews worked toward completion of the tunnel, the BPR awarded a third contract to the Nevada Contracting Company to place oil-mixed gravel surfacing and construct additional guardrails on Section 1, place a concrete wearing surface and curb on Section 2, and to construct the masonry portal at the west end of the tunnel. The tunnel project had revealed additional requirements, including concrete lining at Galleries 6 and 2, an added 400 linear feet of timber lining, and a 1" layer of gunite on the tunnel roof (spring line to spring line) where lining was not already provided. This work was awarded to the same contractor, who subcontracted guniting to the Cement Gun Construction Company of San Francisco; all surfacing to Ora Bundy of Ogden, Utah; production of aggregates to the Cedar Construction Company of Cedar City, Utah, who used a gravel pit just south of Rockville for this work; and laying of the west portal arch to Shea and Shea. Subcontractors completed the project between 15 June 1929 and 6 January 1930. Due to poor planning and supervision, the general contractor lost $31,000 on payments of $170,000 from the BPR.[27]

Sections 1 and 2 were completed by 6 January 1930, a little more than two years and three months from the first clearing of right-of-way along Pine Creek. Timetables for total project completion required that work begin on Section 3 prior to finishing the first two sections, however, and the BPR assigned Highway Engineer F. LeRoy Davis to resurvey and restake the last section while work on the first two sections progressed. The final design for construction replaced four tunnels and two bridges originally envisioned with steeper grades and cuts, but retained one tunnel at Station 268+73-273+60 (see HAER No. UT-39-F, Short Tunnel) and substituted one 12' masonry arch culvert between stations 216+39 and 225+00. Five masonry arch culverts with 12'-16' spans at Stations 267+15, 313+27, 324+03, 342+25 and 372+10 had been specified, but all except the one at 342+25 were replaced by 9'x9' unlined water tunnels which would cost the same yet expedite the road work. A few minor changes were also made to line. As previously noted, Section 3 was opened for bid under the revised designs 27 September 1928, and awarded to the Nevada Contracting Company 9 October after they agreed to begin work

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[27] Brown, "Final Construction Report, 54-56"; Garate, "The Zion Tunnel," 46. The gravel pit used by the Cedar Construction Company is still used and is located by crossing the Rockville Bridge and following the old Rockville Shortcut road about one mile to the pit on the north side. In 1993, the pavement ends at this point where the road makes a sharp curve to the left and continues with a gravel surface.

despite the fact that the NPS had run out of money to continue the project.[28]

Although the overall road project had been underway for some two years, the terrain which Section 3 would traverse was still inaccessible when it came time to begin construction. The State of Utah had been at work on its 16-mile federal aid project from Mt. Carmel to the park's east boundary, but had not yet completed the road. Main bore crews were about to hole out at the tunnel's east portal on 19 October, but when they did they would be confronted by the deep ravine of upper Pine Creek. Because project specifications allowed only 250 days to complete the section, and the general contractor knew that the rugged slickrock would present problems even when he achieved access, he elected to subcontract the eastern portion of the project to Raleigh-Lang Construction Company of Springville, Utah, contractors on the state section. Raleigh and Lang's crews were approaching the park boundary from the east, thus, they had men and equipment ready to start work immediately. They were assigned road construction from Station 387+46 (eastern park boundary in 1928) west to Station 274+24 near the east portal of the proposed short tunnel.[29] Bridge work east of the main tunnel was contracted to the Reynolds-Ely Construction Company, which also had the contract to build the Virgin River and Pine Creek bridges.[30]

The Nevada Contracting Company decided to move east toward Raleigh and Lang as soon as they opened the tunnel to full bore, and from the start faced a number of topographical challenges. On 20 October 1928, they began work on a 100' temporary bridge over the upper Pine Creek gorge immediately east of the tunnel portal. Once complete, they had to obtain permission from the

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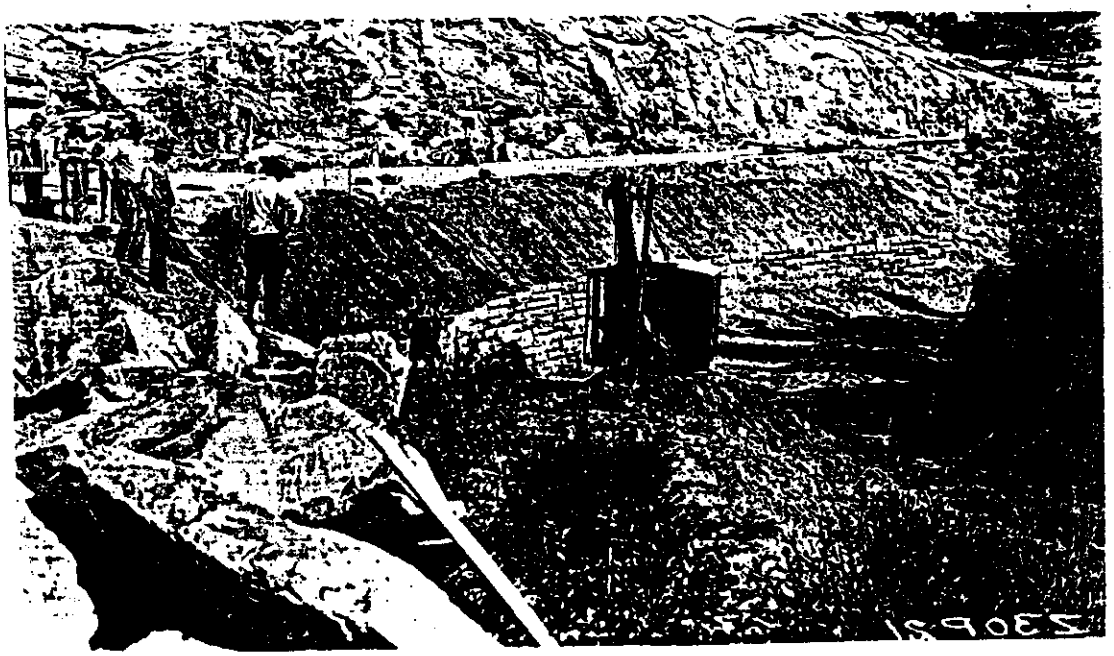
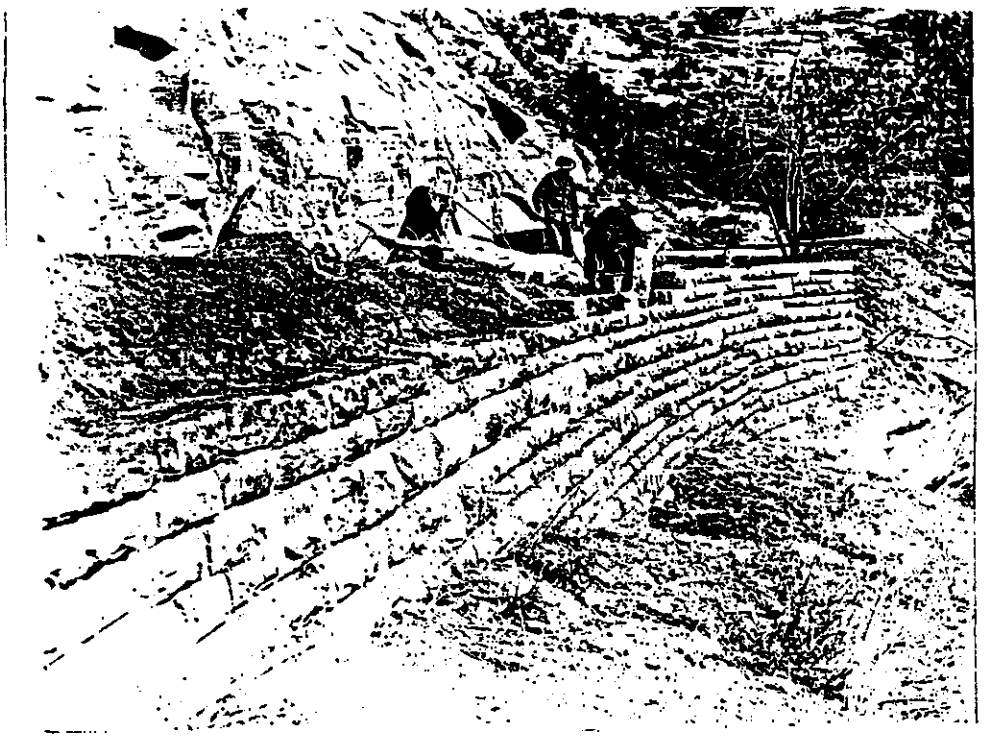
[28] Brown, "Final Construction Report," 46-48. The agreement was that the contractor would wait to get paid until Congress appropriated the funds in December. The contractor was, in fact, paid at the completion of the project.

[29] Brown, "Final Construction Report," 48.

[30] Garate, "The Zion Tunnel," 46, states that the bridges on the "east side of the project" were completed by the Whitney Construction Company, but in his published The Zion Tunnel, 39, he states that they were completed by Reynolds-Ely. See also HAER No. UT-39-D report entitled "62' Concrete Arch Pine Creek Bridge" by Julie W. Osborne, who identifies Reynolds-Ely as the builder of all bridges along the highway.



Backfilling retaining wall construction with a Park power shovel -- east of tunnel. (Zion NP archives)



Works Project Administration building retaining wall -- east of tunnel, 1942. (Zion NP archives)

NPS to blast along the side of a ridge--the top of which was 70' above road grade and just a short distance east of the bridge--just to move equipment and supplies further east. These preliminary operations required three weeks and added little to the permanent road and structures required of the contract. Once complete, the contractor began other preparations including laying air, water, telephone, and electric lines from the main tunnel to a camp at the site of the short tunnel near Station 269+00. Men had to blast the Clear Creek channel to move wagons loaded with equipment from the east to this site. By 15 December, they had completed a camp which could accommodate fifty men, and by 23 December, had used P. & H. 3/4 yard and 1-1/4 yard shovels to complete a pioneer road from the main tunnel to this site at the short tunnel's west portal. Finished preparatory work by this date also included installation of one large Sullivan Stationary compressor and a 150-HP motor in the vicinity of Station 218.00, and a 2300-volt power line which ran around the face of the main tunnel cliff, through Gallery 4 and the main tunnel, and on to the construction site.[31]

The decision to place a 12' span masonry arch culvert near Station 221 caused considerable project delays and expense. Until fill could be placed over the arch, men had to build a temporary steep and crooked pioneer road around it on the south side of the creek to avoid marring the landscape. While masons constructed the arch between 1 January and 1 June 1929, shovel operators widened the pioneer road to line and grade along most of the project and crews worked on retaining walls, culverts, bridges, water tunnels and the short tunnel. Contractor built the short tunnel through Stations 268+91 to 274.00 between 16 February and 29 May 1929. Crews began work on the permanent bridge across upper Pine Creek at Stations 201+20 to 202+50--called the "upper Pine Creek Bridge" to avoid confusion with the Section 1 Pine Creek Bridge--on April 1st and completed the structure 23 July 1929. This bridge cost the government $22,795.36, including engineering. Unlined water tunnels designed to carry water away from the road at Stations 267, 313, 324, and 372 were bored between 6 April 10 and July 1929, and measured 136', 205', 50', and 140', respectively. The general contractor completed all the above work by 31 July 1929. In the end, the Nevada Contracting Company lost approximately $5,700 on Section 3, which was attributed to poor supervision, rough

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[31] Brown, "Final Construction Report," 48-50.

terrain, and tactical errors such as operations around the masonry arch and failure to plank the very fine blasted sandstone surface which slowed the movement of equipment.[32]

Raleigh and Lang had a much easier time completing the far eastern segment of Section 3. The subcontractor began work on 8 November 1928, and moved westward by alternately drilling and blasting ahead, then following up with 3/4 yard and 1-1/4 yard Northwest shovels to excavate a pioneer road to place the drainage structures. Crews completed drilling and blasting to Station 275 on 1 June 1929; shovel operations by 6 July; and cleanup by 13 July. Project acceptance awaited Nevada Contracting Company's completion of its Section 3 segment 31 July 1929. The BPR noted that Raleigh and Lang Superintendent E. L. Brannon managed his project well and that the subcontractor made a little money for his efforts on payments of $.90 per cubic yard for 80,000 cubic yards of excavation.[33]

Once the contractors had completed the major work on Section 3, the BPR completed project specifications for a selected surface contract which included a layer of clay to the road subgrade (due to the fine sand left from blasting), a gravel surface lightly treated with oil, a few additional minor culverts, and widening of a few cuts. Ora Bundy of Ogden, Utah, won the contract 2 November 1929, but did not start surfacing until December 7th due to exceptionally dry conditions. He worked from that date through 10 January 1930, and again from 21 February until completing the project 4 April 1930. Bundy made a profit of about $4,000 on expenditures of $22,000.[34]

Although the three sections of road had been fairly completed by April 1930, Reynolds-Ely continued to work on the major bridges west of the tunnel and would not complete them until August. As previously noted, the Reynolds-Ely Construction Company had secured the contract to complete bridges spanning the North Fork Virgin River and Pine Creek on 30 August 1929. The late award was due to rejection of the first bid, a redesign of the structures, and arguments concerning landscape characteristics (ultimately, Harry Langley, the park's first landscape architect,

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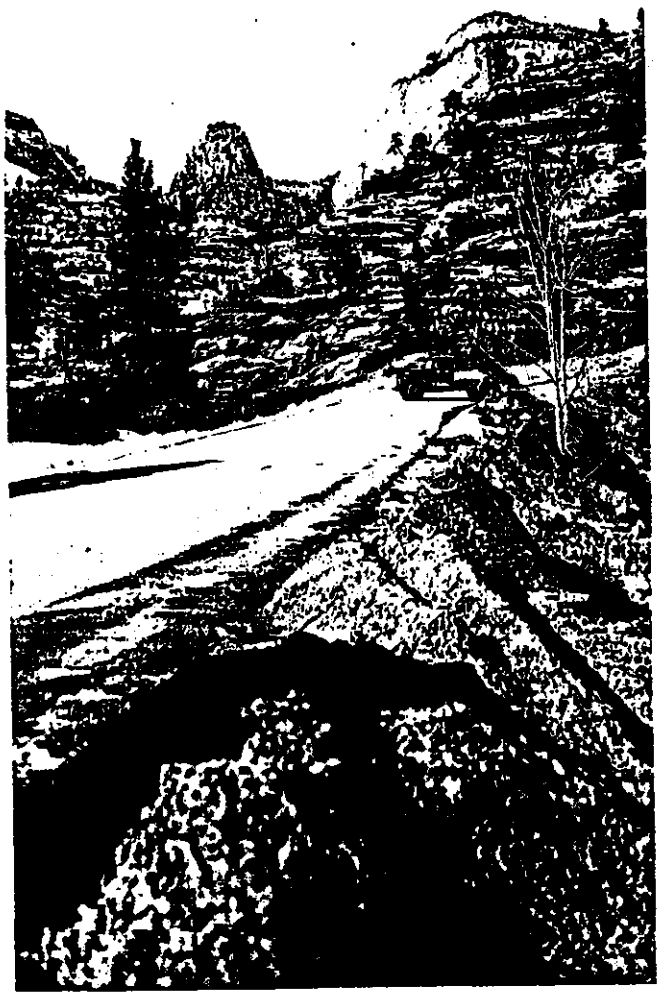
[32] Brown, "Final Construction Report," 50-51, 53.

[33] Brown, "Final Construction Report," 52-53.

[34] Brown, "Final Construction Report," 57.



Widening the grade one mile east of the short tunnel. 1950. (Zion NP archives)

Civilian Conservation Corps sloping road banks -- 1935. (Zion NP archives)

built the entire Pine Creek Bridge to scale using bars of soap to get it the way he wanted it).[35] The late start was perhaps fortunate as the bridges thereby escaped the ravages of heavy equipment traffic during road construction.

The contractor began work on the new North Fork Virgin River Bridge 7 October 1929. Specifications called for a 185' span with 24" x 36" I-beams, concrete deck, masonry piers, concrete abutments faced with masonry, and redwood handrails. Shortly thereafter, on 10 November, construction of the Pine Creek Bridge began and work on both bridges progressed simultaneously. The latter bridge design called for a 65' solid masonry keystone arch supported on concrete piles and footings, with spandrel and wing walls of reinforced concrete faced with masonry. Difficulties with excavation required the contractor to substitute a cellular concrete footing on the south side of the creek and wood piles driven to bedrock on the north side. The contractor obtained the brilliant array of colorful rocks from different park areas. Finishing work on the Virgin River Bridge was completed August 9, 1930 and on the Pine Creek Bridge 22 August 1930. Costs totalled $66,416.11 for the former structure and $72,947.95 for the latter, including construction engineering costs. Reynolds-Ely lost $21,000 on the overall project, which included minor road work, on payments from the government of approximately $172,000 (see HAER Nos. UT-39-B and UT-39-C for construction details).[36]

Admirers have long appreciated the beauty of both structures, and the Pine Creek Bridge has the distinction of being one of the first solid masonry arch bridges designed by the Bureau of Public Roads for the National Park Service. The Virgin River Bridge underwent major widening modifications in 1959-60, but retains its structural integrity below roadway level. The Pine Creek Bridge, built initially with a wider road surface, has escaped alteration since its completion in 1930. Both structures have proved their worth, withstanding the periodic flooding of the river and creek without damage. BPR reports of the time attributed the fine results to the general superintendent on the project, "who took great pride in the work done... and was inclined to incorporate into the work a greater degree of refinement than actually specified."[37] Completion of the Zion-Mount Carmel Road awaited only minor cleanup and repairs, which

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[35] Garate, "The Zion Tunnel," 46-47.

[36] Brown, "Final Construction Report," 58-59.

[37] Brown, "Final Construction Report," 58-63.

included ordinary maintenance, slide removal, reinforced timber lining within the tunnel, road shoulder repairs, clay surfaces to road shoulders, and repair of the oil-mixed gravel wearing course, at a total cost of $13,062.34. The BPR completed this work as required with day labor forces between February 1929 and August 1930, on which date the entire project was accepted by the National Park Service. Despite the required cleanup work and bridge construction still in progress, the highway opened to general traffic months earlier on 3 January 1930.[38]

Formal dedication of the Zion-Mount Carmel Highway took place on 4 July 1930, an especially appropriate day since a national governors' conference had ended at Salt Lake City just a few days earlier and the opportunity to show off the new highway could not be missed. Union Pacific tour buses transported most of the governors along with NPS Director Horace Albright, Zion National Park Superintendent Eviend Scoyen, LDS Church President Heber J. Grant, and other dignitaries to the Zion Lodge on 3 July. The following morning nearly a thousand people gathered at Gallery 1 for the ceremony, including road workers, members of the state road commission, local residents, and representatives of nineteen newspapers. Speakers included Thomas H. McDonald, Chief of the Bureau of Public Roads, B. J. Finch, district engineer and the man instrumental in laying out the highway some seven years prior, and Utah Governor George H. Dern. After the ceremony, dignitaries continued on their way to tour Bryce and the Grand Canyon--destinations which had been brought into a tighter "Grand Circle" by completion of the Zion-Mount Carmel Highway.[39]

Total cost of this 8.5-mile segment of National Park road construction to 1930 merits delineation:[40]

Utah #1657: Sections 1 and 2	$728,020.37
Utah #1663: Section 3	340,398.92
Utah #1678: Sections 1 and 2 surfacing	182,692.88
Utah #1691: Section 3 surfacing	28,337.98
Utah #1675: Section 1 bridges [and misc minor road]	172,628.74
Utah #1695: Constr. Eng. cost of rejected bridge bids:	828.02

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[38] Brown, "Final Construction Report," 63-64; ZNP Superintendent's Annual Report, 1930, history boxes, ZNP archives.

[39] Garate, "The Zion Tunnel," 48-49.

[40] Brown, "Final Construction Report," attached financial statements.

Utah #1676:	Section 1 & 2 force account misc. work* :	10,111.84
Utah #1692:	Section 1 & 2 force account misc. work* :	2,950.50
Utah #1606:	Survey, plans, estimates Pine Cr. route :	13,578.34
Utah #1628:	Survey, plans, estimates Parunuweap route:	6,406.79
Utah #1658:	Reconnaissance surveys :	234.67
	Total Costs :	$1,486,189.05

* $10,930.47 of force account work paid for by Zion National Park.

Adding the cost of the state's 16.5-mile portion of the highway--which the state road commission completed in 1929 and considered one of its most expensive road projects ever undertaken--costs for initial construction of the entire 25-mile Zion-Mount Carmel Highway totalled approximately $1,942,189.[41]

Some of the road's vital statistics:[42]

Length of Section 2 (tunnel)	5,613'
Full bore tunnel dimensions	16' high x 22' wide
Depths of galleries	12' to 25'
Widths of galleries	15' to 150'
Grade in the tunnel	<5 percent
Subgrade of roadway	sandstone bedrock
Wearing surface of roadway	concrete
Length of Section 1	3.51 miles
Width of grade	22'
Width of roadway	16'
Grade in the switchbacks	<6 percent
Number of lines	7
Subgrade of roadway	4" clay atop graded dirt
Wearing surface of roadway	4" deep oil-mixed gravel
Length of Section 3	3.44 miles
Width of grade	22'

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[41] Garate, The Zion Tunnel, inset, back cover; ZNP Superintendent's Annual Report, 1929, history boxes, ZNP archives.

[42] Garate, The Zion Tunnel, inside covers. Garate gives the tunnel grade as 3.3 percent while construction reports say 5 percent. Statistics for Sections 1 and 3 and some tunnel statistics obtained from Brown, "Final Construction Report," attached final inspection reports.

Width of roadway	16'
Subgrade of roadway	red clay atop graded dirt
Wearing surface of roadway	4" deep gravel, light oil

Major Repairs and Alterations

Construction costs of the Zion-Mount Carmel Highway might more accurately include the immediate followup repair work required in 1932-33. Road and tunnel inspections of 1931 and 1932 led the BPR to conclude that portions of the tunnel were unsafe as constructed and portions of the road immediately below the tunnel required work to alleviate dangerous rockslide conditions. The BPR prepared a survey, plans, and estimates for the work and the Reynolds-Ely Construction Company of Springville, Utah won the contract for the low bid of $112,737.85 on 20 July 1932.[43]

The contract contained 28 construction items, all but one associated with tunnel enlargement and additional tunnel lining (see HAER UT-39-A for construction details). Road work within the tunnel entailed resurfacing 137 linear feet with concrete between Stations 72+64 and 73+94, to a width of 20' and a depth of six inches, due to the collapse of the ceiling in that area during tunnel reconstruction. Road work west of the tunnel required stabilization of the slope below Stations 77+00 and 88+00 corresponding to the slope above Stations 106+00 and 114+00, which contained dangerous surface rocks and had been sinking since construction. Crews shot the dangerous rocks, shifted the road, and sculptured the slope to a flatter angle of repose which corrected the problems. The contractor completed the specified work and change orders on 13 April 1933 at a cost of $152,908.62[44]

Congress enlarged the boundaries of Zion National Park in 1930, shifting the east boundary from the Washington County/Kane County Line 2.44 road miles into Kane County. The State of Utah had

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[43] F. LeRoy Davis, Junior Highway Engineer, "Final Construction Report on East Rim Road Supplemental Construction Route No. 1 Sections 1-A1, 2 and 3, 1932-1933," manuscript, 1935, Zion Tunnel and Road Reports File, Park Administrator's vault, Zion NP, 2-7.

[44] Davis, "Final Construction Report Supplemental," 7, 23-24, attached financial statements.

completed this section of road in 1929 through Federal Aid Project #104-E and its contractor, Raleigh-Lang Construction Company. This segment of road, which carries the Zion-Mount Carmel Highway through the last miles of jumbled slickrock to the eastern plateau, was built to modern highway standards of the time, but to something less than NPS standards. For example, cuts through the slickrock were (and still are) as deep and narrow as gun sights. The two concrete bridges constructed (see HAER No. UT-39-D and HAER No. UT-39-E, replaced in 1992-93) were fine examples of Utah Road Commission bridges of the 1920s and 1930s and quite attractive from a modern perspective, but did not exhibit the workmanship nor rustic style of the park bridges at the North Fork Virgin River and Pine Creek, and were viewed as simple utilitarian structures in the year built. The roadway itself was 18' wide--2' wider than the NPS road sections--but given only a crushed gravel wearing surface which was dusty and prone to corrugation.[45]

Harry Langley reported in late 1930 that this section of road left something to be desired in the way of "roadside cleanup." Aside from cleaning up the mess--which included loose dirt and rock piled in various locations, abandoned dump cars, and cuts that had not been rounded to expose the natural slopes--Langley suggested staining the exposed surfaces of Clear Creek Bridge, replacing the pipe railing of Co-op Creek Bridge with a stone guard rail, and staining all wooden guard rails amounting to about 2,025 linear feet. He suggested that the work be completed when the state officially turned over this section of road. The state road commission officially did so in September 1933, and the Civilian Conservation Corps (CCC) completed some cut bank sloping from the tunnel to the park's new east boundary in 1934-35, and the Coop Creek Bridge railing was later replaced with a concrete arch balustrade railing, but it is unknown when other of Langley's suggestions were carried out.[46]

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[45] Brown, "Final Construction Report," attached map of construction; Field observations, 2 July 1993.

[46] Harry Langley, Assistant Landscape Architect, "Report to Chief Landscape Architect on 2.5 Mile Extension to East Rim Road," manuscript, 3 November 1930, history boxes, Miscellaneous File, ZNP Archives. This report has several good photographs of the 2.5-mile section of road and the two east side bridges immediately after construction. See also ZNP Superintendent's Annual Reports, 1930, 1933, 1935, history boxes, ZNP archives.

When considering the work performed to the Zion-Mount Carmel Highway since its construction, it is first worth noting that annual and periodic maintenance are and always have been continuous requirements. Very few years have passed where park maintenance crews have not had to clean out culverts and/or road drains, clear slides, blade and oil treat the wearing course (in the days of gravel surfacing), patch and chip-seal the wearing course (today), and clear frequent rockslides and occasional landslides--especially along the switchbacks. This type of work is mentioned in nearly all of Zion National Park's annual or monthly superintendents' reports. The park has kept the road open in winters since it was first constructed, fulfilling one of the road's original purposes, thus, snow removal is another annual maintenance task. Snow, ice, thaw, freezing temperatures followed by blistering summer heat, rain, wind, wear, and gravity are principal destroying agents to the exposed road, while landslides from the cliffs constantly threaten the main tunnel.[47] One such landslide occurred soon after the tunnel was completed when a massive portion of the cliff above Gallery 6 flaked along regular fault lines of the Navajo Sandstone in 1934. Massive chunks of stone crashed to the talus slope immediately below the gallery, but no damage occurred within the tunnel. On 2 January 1942, a rockslide of an estimated 2,850 cubic yards left a fresh wound in the Navajo sandstone cliff west of Gallery 3 measuring 70' high, 50' wide, and 18' deep, but did no damage to the tunnel nor to the gallery.[48] Slides of 9 October 1949 and spring 1950, damaged the reinforced concrete arches of Galleries 4 and 5. The largest and most damaging slide to date occurred 28 April 1958, far above and immediately west of Gallery 3, when 80,000 tons of rock plummeted to Pine Creek, with enough of it deposited through the gallery to nearly block off the tunnel. This slide basically destroyed the gallery's reinforced concrete canopy, and led to the installation of electronic sensors to monitor sandstone movements.[49] Despite builders' best precautions within the

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[47] Dave Karaszewski, Chief of Zion Park Maintenance, taped interview by Michael F. Anderson, 9 July 1993. The author reviewed all superintendent's annual reports between 1929 and 1942, as well as most of these reports through the late 1960s. Each report contains at least mention of required maintenance due to the causes cited. Weather--snow, rain, floods in particular--causes most of Zion's road problems.

[48] Dave D. Hendricks, Assistant Engineer, to Superintendent Franke, memorandum, 14 January 1942, Landslides: Road Damage and Repair File, history boxes, ZNP Archives.

tunnel, which included portal to portal lining and thick gunite applications, nothing could nor can be done to prevent further sloughing along the cliffs, and slides will always be a threat.

The highway's wearing course has demanded continuous repairs through the years as visitation has increased within the park from approximately 55,000 in 1930 to nearly 3 million in 1993. Although the tunnel's concrete surface has stood up to traffic fairly well (less susceptible to weather), all other section surfaces began as oil-mixed gravel or selected gravel materials--standard surfaces of modern highways in 1930. Park Superintendent Preston Patraw noted in 1932 that Section 3 had received "only a very light surfacing and dust oiling, and maintenance of a good surface under heavy traffic [was] impractical." He also noted in this year and in 1933 that extensive patching was required to road and shoulders on both Sections 1 and 3. Dust, too, created problems and the road and small tunnel surfaces had to be oiled frequently until they were paved. With an ample park work force consisting of up to 500 or more depression-era laborers, the park began to mitigate these problems in 1934. In that year, the superintendent noted that the highway was being surfaced with an asphalt-mixed gravel and that "all roads within the park are now hard-surfaced, eliminating the necessity of frequent blading."[50]

The 1930s were, paradoxically, good years for construction and maintenance in Zion National Park. Crews of the Works Progress Administration (WPA), Public Works Administration (PWA), and Civilian Conservation Corps (CCC), as well as local force labor hired at the park's discretion, performed hundreds of necessary tasks throughout the park as well as at nearby Bryce and Cedar Breaks. Although these crews seldom assisted with main road construction (they did construct service roads), they performed many maintenance tasks on the Zion-Mount Carmel Highway--such as slide clearance and culvert cleaning--and some construction-related tasks including building masonry retaining walls, guardrails, catch basins and culverts; cut bank sloping; and slope revegetation. The CCC also constructed some related features, such as the east (1934-35) and west (1934) entrance sign pylons. During these years park maintenance funds were cut and often ran out before the end of each fiscal year, leaving

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[49] Garate, "The Zion Tunnel,", 51-52. Karaszewski interview, 8 July 1993.

[50] ZNP Annual Superintendent's Reports, 1930, 1932-1934, history boxes, ZNP archives.

road maintenance to whatever these crews could accomplish. The depression-era crews could and did accomplish much under the supervision of experienced workers, but as the superintendent lamented in 1940, only about $80,000 for materials, supplies, and equipment came along with the men.[51]

America's Great Depression framed the halcyon years for the Zion-Mount Carmel Highway. It was a time when road and associated structures were new, and plentiful labor built additional road structures while literally looking for maintenance tasks to accomplish. Relatively few vehicles moved slowly over a recently paved road, and the largest vehicles park rangers noted were the few daily, Union Pacific 17-passenger touring buses. New construction, much of the maintenance, and a high percentage of the tourist business came to an end, however, with the declaration of war 7 December 1941. As the last CCC and WPA crews left in mid-1942, the federal government declared the Zion-Mount Carmel Highway, its two tunnels, and six highway bridges strategic to the war effort and the park assigned extra men to patrol, guard and watch.[52] But gasoline and rubber rationing kept tourists away in droves; and the Japanese never showed up.

The World War II years were not good ones for the national parks. Generally, the NPS director, Newton B. Drury, had his hands full keeping the lumber and cattle interests out of the parks, while park administrators tried to keep up with wartime paperwork, minimal budgets, and fewer experienced people. The NPS saw its budget drop from $30 million in 1940 to $24 million in 1941, $21 million in 1942, $6 million in 1943, and $5 million in each of 1944 and 1945. These reductions reflected a steady drop in construction programs, including road construction programs, beginning with the National Defense Program buildup of 1939-40 until 1942 when all non-defense government construction projects were halted in the United States. From 1943 through 1945, Park

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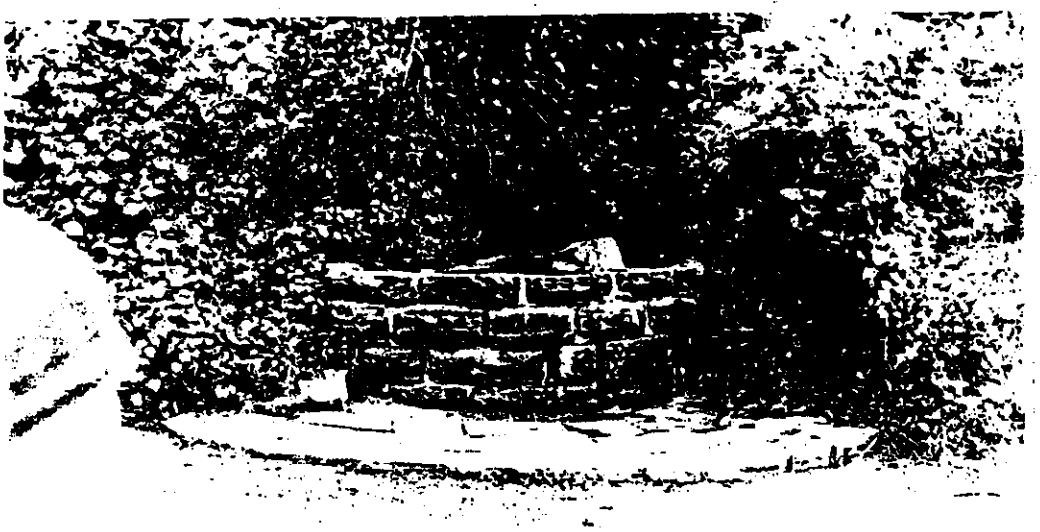
[51] ZNP Annual Superintendent's Reports, 1933-1940, history boxes, ZNP archives.

[52] ZNP Annual Superintendent's Report, 1942, history boxes, ZNP archives; See miscellaneous statistical information in "General Information:Statistics," loose leaf notebook, Miscellaneous File, history boxes, ZNP archives.

Automobile traffic rose steadily at the park in the 1930s, from 15,744 cars in 1932 to 30,171 in 1935, and continued to climb until war rationing and the war labor effort ended tourism for most Americans.



PW-7-364-34

Fountain along the switchbacks built by Public Works Administration -- 1934. (Zion NP archives)

Clearing a slide at the Nevada Switchback -- 1950. (Zion NP archives)

Service allocations went strictly toward administration, protection, and maintenance. Personnel strength likewise plummeted, from 6,000 in mid-1941 to 1,500 by mid-1944.[53]

National park visitation also dropped from 21 million in 1941 to 8 million in 1944 due to rationing, restrictions on non-essential travel, and a citizenry engrossed in the war effort. But as Drury phrased it, there were 4,000 miles of roads in the park system and most of them in tough, mountainous terrain where the weather is extreme and maintenance costs high. A drop in visitation did not translate into a drop in maintenance costs. Too, most experienced engineers and road workers had gone off to war, leaving boys and old men to man the road equipment, which itself deteriorated during the war years. Park personnel did the best they could to maintain the roads, but everyone in the Service, especially Drury, knew that a massive program of equipment purchase, road repairs, and construction would be necessary before the parks could again accommodate peacetime visitor numbers.[54]

The war years at Zion basically reflected the NPS experience nationwide. Visitation dropped 60 percent in 1943 from the previous year, and although Office of Defense Transportation orders which banned sightseeing and charter buses did not apply to those operating between railroad terminals and national park facilities, the Utah Parks Company--whose business by this time was largely tourists arriving in automobiles--shut down its operations in 1942 with no intention of reopening in 1943. Zion's war time superintendents, Paul R. Franke and Charles "White Mountain" Smith, made do with fewer and less experienced road personnel. For example, Franke noted in 1943 that 8' of snow had buried the Zion-Mount Carmel Highway at Checkerboard Mesa, and that the entire park staff including clerks were pressed into service to clear it.[55] Zion's roads were fairly new

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[53] Charles W. Porter, ed., "National Park Service War Work: December 7, 1941 to June 30, 1944," manuscript with supplement for period June 30, 1944 to October 1, 1945, by Newton B. Drury, Miscellaneous Historical File, history boxes, ZNP Archives, 48-54.

[54] Porter, "National Park Service War Work," 53-54, supplement, 9; "Administration: General," manuscript, 1952, history boxes, ZNP archives.

[55] ZNP Superintendent's Monthly Narratives, June, July, August, October 1942 and January 1943, history boxes, ZNP

and well-maintained when the nation went to war, and the "war effort" along with reduced visitation would limit complaints for the duration, but the resurgence of tourism in 1946 would call for an accelerated road improvement program.

Despite the visitors' immediate return to the parks in 1946, allocations for road building and other improvements to park infrastructures lagged behind necessity until the onset of the Mission 66 program in the middle 1950s. Mission 66 was undertaken in 1956 as a ten-year plan to rebuild the national park infrastructures, which had deteriorated since the Second World War and had fallen behind the needs of explosive visitation numbers. Its programs at Zion National Park centered on a new visitor center, improved service roads and campgrounds, added staff housing, and improved water and sewage treatment systems, but also included plans for a new alignment of the park's entrance road from the south entrance to the North Fork Virgin River Bridge. Standard maintenance to the park's roads also improved during these years.[56]

In spring and summer of 1958, the entire 11 miles of Zion-Mount Carmel Highway within the park (aside from the tunnel) underwent heavy repairs, and descriptions of the work implied that the roadway had been neglected since the war years. Crews worked on the eastern 6 miles first, liberally pouring blacktop to bring all "worn and sagged places" up to grade. "Surface failures" were ripped out and refilled, then the entire roadway chip-sealed for a new wearing surface. By the end of June, park crews had completed similar work on the road below the tunnel. The highway probably appeared as new upon completion, but the superintendent noted typical summer conditions that year which would have taken the edge off the newness. July cloudbursts filled and blocked with debris 90 percent of the roads' culverts, and by the end of

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archives; Porter, "National Park Service War Work," 21-22.

[56] ZNP Superintendent's Monthly Narratives, March, 1956, history boxes, ZNP archives. Plans for road realignment and the new visitor center began in late 1955 and early 1956. The BPR completed the survey for the road work in March, 1956. The author reviewed the monthly reports from 1956 through 1966 to assess the extent of Mission 66 work.

See Michael Frome, Regreening The National Parks (Tucson: University of Arizona Press, 1992), 2, for one of many observations that the federal government neglected the parks in the decade following World War II.

the summer the park had spent $8,000 just to remove 10,000 yards of material from washouts, slides, and "mud runs" across the highways. This process of major road repairs and chip-sealing (followed by deterioration through wear, weather, and erosional processes) has followed a roughly 7-year replacement cycle since the 1950s.[57]

One instance of major resurfacing of the Zion-Mount Carmel Highway during the Mission 66 period entailed the widening of the North Fork Virgin River Bridge in 1959-60. This work began in December 1959 as a part of south entrance road reconstruction and crews completed the project in April 1960. Beginning on the bridge's downstream side, crews blasted and drilled the 5-foot wooden sidewalk and concrete curb, leveled the edge, placed steel-reinforcing bars in the resultant trench, placed forms, then poured concrete to road level. They finished the downstream side in February 1960, then went through the same steps on the upstream side, completing the entire project in April, 1960, with a wearing course of asphalt. Photographs of the reconstruction indicate that the bridge's wooden guardrails were also reconstructed at this time. Wing walls were also extended at the east end of the bridge in May 1963.[58]

In the early 1960s, the park naturalist's staff developed roadside interpretive exhibits for the park's major highways. These consisted of sixteen "metal photographs" on seven routed aluminum exhibits, which were completed in November 1963.

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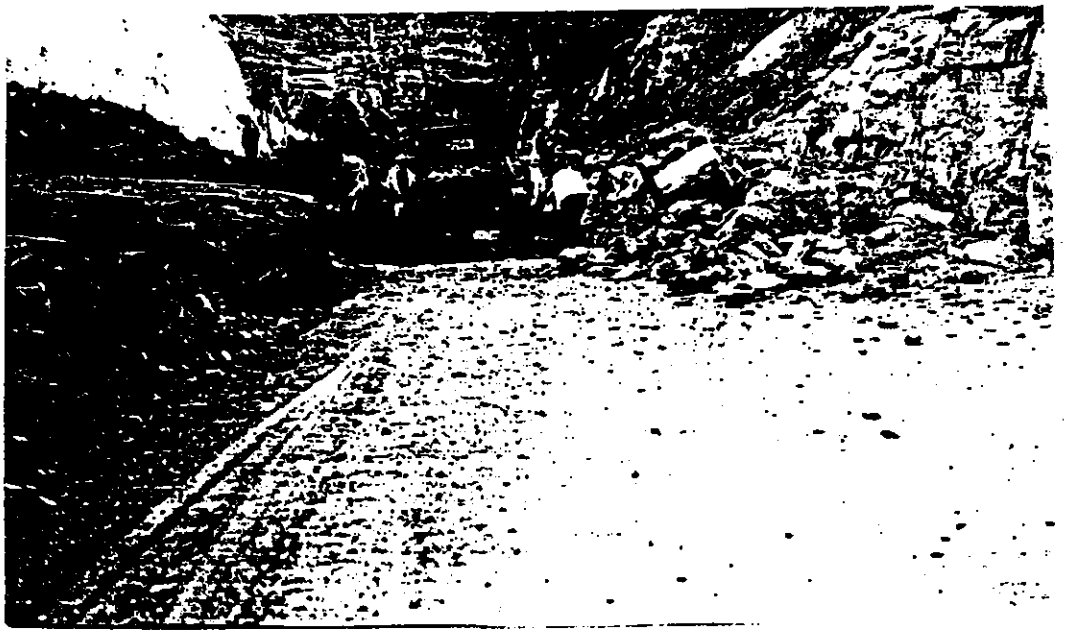
[57] ZNP Superintendent's Monthly Narratives, April, May, Jun, July, September, November 1958; April, 1962; October 1963, history boxes, ZNP archives; Dave Karaszewski interview, 8 July 1993. See also, Annual Narrative Report of the Superintendent, 1962, history boxes, ZNP archives.

A review of all monthly narratives between 1954-1966, along with information from Dave Karaszewski, who has headed the park's maintenance efforts for the past ten years, leads the author to assert the approximate 7-year cycle. Karaszewski believes that the subgrade and base asphalt of the highway is the original, and that succeeding layers of blacktop and chip seal have filled some sunken sections of road to a depth of 10' or more.

[58] ZNP Superintendent's Monthly Narratives, December 1959 (with attached photograph); January, February (with attached photograph), March 1960; May 1963, history boxes, ZNP archives. See also James Jurale, "Classified Structure Field Inventory Report, Virgin River Bridge," 1984, history boxes, ZNP archives.



Removing slide debris on the switchbacks -- 1932. (Zion NP archives)

Debris left in the tunnel from cliff slide at Gallery 3 -- April 1958. (Zion NP archives)

Nothing was found in this study to confirm that these particular exhibits were installed, but similar routed metal exhibits are today found atop masonry pillars along the highway and may be those developed in 1962-63. Other 1960s highway alterations included many of the paved scenic overlooks which were developed in 1962 and 1968.[59]

Major reconstruction to the Zion-Mount Carmel Highway has occurred recently as the NPS in the summer of 1993 is replacing the Coop Creek and Clear Creek bridges built in 1929 and 1930 by the State of Utah, and extensively altering the short tunnel and its approaches. The park initiated this work and redevelopment of the Checkerboard Mesa scenic overlook in the autumn of 1992 for safety reasons. The Federal Highway Administration considered the bridges functionally obsolete because they contained inadequate approach alignments and too narrow a roadway for modern vehicles. Although contributing structures to the highway, which itself is listed in the National Register of Historic Places (1987), the FHwA suggested their replacement before these problems and a generally deteriorating condition forced an emergency shutdown of the road. The tunnel, another historic contributing structure, was also considered too narrow and to have too low a clearance for modern high-profile vehicles, and it, too, required correction of its east entrance road centerline alignment. Construction was still in progress as this report was prepared.

The site of the old Clear Creek Bridge, also known as the "62' Concrete Arch Pine Creek Bridge," is approximately 1.9 miles from the east entrance to the park along the road segment acquired by the park in 1933. The old bridge was a reinforced concrete open spandrel arch structure with a girder and floor beam system, the deck structure of cast-in-place concrete. It consisted of two continuous arch ribs spanning 66' with a total bridge length of 99'-102', an approach roadway width of 28', a deck width of 23.2'

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[59] ZNP Superintendent's Monthly Narratives, April, May, June, July 1962; August, October, December 1963, history boxes, ZNP archives. See also James Jurale, "Classified Structure Field Inventory Report, Zion-Mt. Carmel Highway," 1984, history boxes, ZNP archives.

The park superintendent and naturalist made field trips in 1962 to look for appropriate points to develop scenic overlooks and place interpretive exhibits. Some were developed in 1962, and 1968 per Jurale, but note that some overlooks have existed since the road was first built.

and roadway width of 20'. The cast concrete arch balustrade railing had a continuous concrete cap and featured recessed, exposed-aggregate end-panels (the "signature" of early Utah Road Commission bridges). At the time of its demolition, it had not been altered significantly since its construction in 1930, but it was considered to be in a "generally deteriorated" condition and had an estimated remaining service life of only five years.[60]

The arched support system has been replaced by a single support pier system of prestressed, reinforced concrete girders. Plans as work progressed in the summer of 1993 called for the new bridge to follow the visual integrity of the old by using stone veneer to the concrete core bridge guardrail to match the color, size, and pattern of stone retaining walls found along the highway. Exposed concrete would be blended to the landscape by using an integral coloring pigment or a concrete color stain. The old tangent alignment would remain, but the centerline alignment would be shifted, requiring rock excavation south of the road on the east approach and a fill section on the south side of the road on the west approach. Nearby culverts and interpretive exhibit would not be affected. Other aesthetic plans called for red chip-sealing to blend with the roadway's wearing surface, stain to freshly exposed rock scars to blend with the old scars, and removal of drill scars.[61]

The site of the old Co-op Creek Bridge is approximately 1/2 mile from the east park entrance and is also on the 2.44-mile road segment acquired from the state in 1933. The old bridge was a three-span reinforced concrete girder bridge, 95'-97' in length with a 33' maximum span length. The deck structure was cast-in-

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[60] HAER No. UT-39-D report, "62' Concrete Arch Pine Creek Bridge (Clear Creek Bridge)," December 1992, prepared by Julie Osborne of the Office of Burtch W. Beall, Jr., FAIA, Architect, Salt Lake City, Utah in anticipation of the bridge's replacement; National Park Service, Rocky Mountain Regional Office, "Environmental Assessment: Replace Clear Creek and Co-op Creek Bridges and Enlarge Short Tunnel," booklet, May 1992, copies available at Zion National Park.

Note that measurements given in these two documents often vary for the same structures. The author has considered the sources of each document and made some judgments when the numbers did not agree, or in a few instances, shown the range achieved by the disparities--such as a bridge span of 99'-102'.

[61] "Environmental Assessment."

place concrete. The bridge consisted of three concrete "T" beams supported by six rectangular concrete piers and an arch balustrade guardrail with a continuous concrete cap and recessed, exposed-aggregate end-panels. The approach roadway was 28' wide, with a bridge deck width of 24.8' and roadway width of 22'. At the time of its demolition, it too had not been altered significantly since its completion in 1929 and was considered to be in a fair but deteriorating condition with a remaining service life of only five years.[62]

The old two pier support system has been replaced by a single support pier system with two spans of prestressed concrete girders. Plans as worked progressed in the summer of 1993 were similar aesthetically to the Clear Creek Bridge, with stone veneer guardrails matching highway retaining walls and stained exposed concrete. The tangent alignment would be replaced by a curvilinear alignment matching the road curvature. Centerline alignment would be shifted south 10' and require cutting into an exposed rock face south of the road on the southwest side of the west approach end of the bridge.[63]

The 480' short tunnel is approximately 6 miles from the North Fork Virgin River Bridge, along the Section 3 road segment built by the Nevada Contracting Company in 1929. Prior to reconstructive work of 1992-93, it was unlined with gunite facing on the exposed rock walls. It had a vertical clearance of 16' at centerline and 12' at the curbs. The approach roadway width was 28' while the tunnel roadway width was only 20'. The tangent centerline tunnel road alignment at the west end of the tunnel did not flow smoothly into the curve of the exterior centerline road alignment at the east end, which produced poor sight distance and speed problems. Scratches on the sides and ceiling indicated that large-profile vehicles scraped the tunnel interior with some frequency, and vertical clearances almost assured that drivers of larger vehicles would cross the centerline to effect safe passage. These problems argued for its enlargement.[64]

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[62] HAER UT-39-E Report, "Co-op Creek Bridge," December 1992, Julie W. Osborne; "Environmental Assessment."

[63] "Environmental Assessment."

[64] "Environmental Assessment." Note that this document, and the HAER report by Julie Osborne, give the date of 1930 for the tunnel's completion. The tunnel was completed and accepted by the National Park Surface in the summer of 1929. Only the gravel wearing surface remained to be applied in 1930.

As this report was prepared, crews had nearly completed the tunnel enlargement project and had already blacktopped the roadway. They had enlarged the tunnel by concentrical reaming as planned, leaving an unlined, bare-rock tunnel face--though it is unknown if the opening has been bored to the planned 34' wide, 22.25' high dimensions. They had also skewed the tunnel bore to establish a smooth transition from curve to tangent at the east end of the tunnel. Plans called for possible shotcrete (gunite) over the rock bolting at mid-tunnel, and the elimination of gunite at the tunnels portals (accomplished).[65]

Final construction of the 1992-93 project required expansion of the Checkerboard Mesa scenic overlook due to its popularity and consequent overcrowding, which had caused some visitors to park off road and threaten the landscape. Ongoing reconstruction in the summer of 1993 witnessed the completion of the new road alignment 10' to the side which allows for an expanded parking lot, and men busy rebuilding the masonry guard walls. The goal is to expand parking capability to two buses, one large RV and eight sedan-sized vehicles.[66]

Although this major reconstruction project--coupled with traffic control at the main tunnel--has created an unpleasant experience for the 1993 summer visitor, the work itself has proceeded with as little damage to the landscape as possible. Plans outlined in the May 1992 environmental assessment paid particular attention to existing built historic structures as well as the natural landscape. As an example, a 200' pioneer road was required to access the underside of the Clear Creek bridge, but this road was slated for obliteration, and constructed where later required fill would bury most of it. Attention has also been given to possible archeological sites (none were found), water quality in adjacent streams, erosion checks, and potential vegetal damage.[67] The goals are that the motorist with a discerning eye will have a hard time determining that recent construction has taken place and that environmental quality is in fact maintained.

DESCRIPTION

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[65] "Environmental Assessment."

[66] "Environmental Assessment."

[67] "Environmental Assessment"; Field observations, 4 July 1993.

As noted at points within this report, these same concerns influenced original construction of the Zion-Mount Carmel Road in 1927-1930 and are discovered today in a close examination of the road beginning at the North Fork Virgin River Bridge at 4000' elevation. The first .6-mile road segment is cut into the north slope of the Pine Creek drainage and ascends in an easy grade to the Pine Creek Bridge at elevation 4080'. Boulders blasted and shoved from the roadway into the initial, narrow drainage during construction are today obscured from the motorist's view by heavy vegetation and a slight artificial slope. One such boulder has been left along the south roadside to provide an interesting, intimate aesthetic touch, which offsets the grander view of Mount Spry and the East Temple offered by this first tangent. Several paved scenic overlooks flank the south roadway and the northeast side of the bridge. Nothing of the rest of the road can be seen along this first line until the bridge is approached, and then only the very perceptive will detect the onset of the switchbacks at the opposite side of the bridge.[68]

The Pine Creek Bridge, unaltered since its completion in 1930, spans a somewhat broadened creek drainage, offering the motorist a view of the multicolored sandstone arch from the road above or below the structure. Views of the bridge are partially obstructed by trees and other creek side vegetation, but in the late afternoon or evening, direct sunlight reflects the pastel shades such that the motorists eyes are automatically drawn to the structure. The number of vehicles stopping for a closer inspection are, in fact, greater in the afternoon than in the morning when the masonry blends with the surrounding rocks and motorists hardly notice that they are approaching a bridge. The bridge forms the tangent of a broken back curve, and although the roadway is sufficiently wide to be crossed in safety, the approach alignments--especially that of the south side of the bridge--are sharp and dangerous unless approached with caution. Motorists scrape the approach masonry guardrails with some frequency.

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[68] Notes on the landscape and road in this and succeeding paragraphs are based principally on the author's field observations of 4 July 1993 and from information developed earlier in this report for which sources are given at that point. Some observations, of course, come from any one of a dozen trips made over the road during this 12-week project. The author took 31 field photographs of the road and significant structures, the negatives and contact sheets of which are included in the field notes related to this report.

Beyond the bridge, the roadway ascends the second line heading west, with a grand view of the Streaked Wall surmounted by the Carmel formation Beehives beyond the Virgin River. As the roadway approaches Skinny Bend Switchback, a first instance of low, masonry guardrail is noted on the right. Some of these guardrails along the switchbacks were built following the road's construction after embankments had settled, but many others were built by the CCC in the 1930s. The leading edge of the guardrail that sweeps along the outside curve at Skinny Bend (elevation 4160') contains a tiny glass bead embedded in the mortar--a remnant of one of the earlier reflector systems along the road. The curve itself produces a powerful axis to lead the eye to the distant Streaked Wall, so powerful an aesthetic feature, in fact, that one can easily forget the tight radius switchback and slam into the cliff face around the bend.[69]

The third road line between Skinny Bend and Carl's Bend switchbacks is nearly a mile long, the longest of seven leading up to the tunnel's west portal. It has a 100 percent curvilinear alignment, with each slight and larger curve superelevated to a design speed of approximately 35 miles per hour (superelevation is built into each of the switchbacks as well). There are a number of fine examples of downslope masonry retaining walls which extend slightly above the embankment to form guardrails along this line. Most of these were built during the initial contract for Section 1 roadway. Additionally, small standalone guardrails flank the roadway for most of this line. One large original scenic overlook is found in a shady grotto about halfway along the line on the upslope (south) side of the roadway. It is marked by a lovely stand of cottonwoods laced with wild grape, and contains two circular masonry structures (filled with silt and debris) beneath a seep which probably provided water to motorists in the 1930s. The upslopes along this line are particularly steep, though fairly well-fixed with pinyon pine, juniper, mormon tea, hollyoak, and other high desert grasses and shrubs.

The last short tangent before the curve into Carl's Bend Switchback (elevation 4440') highlights the Great Arch of Zion at the apparent head of Pine Creek. The arch is actually a broad grotto which highway engineers of the 1920s considered

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[69] Most of the author's judgments concerning the roadway's aesthetic features are drawn in relation to the American Society of Engineer's Practical Highway Esthetics (1977), a copy of which is in the National Park Service Library at the Denver Service Center.

penetrating with a spiral tunnel. The short fourth highway line is unremarkable until entering the Sandwich Rock Switchback at 4530' elevation. As the road curves to enter the fifth road line at this switchback, it passes snugly between two large boulders (thus, the sandwich). This is the location of the upper terminus of the aerial tram which supplied the nearby construction camp. Above the fifth line is the approximate 8-acre camp site, which has been totally obliterated save for a few rusted nails and tobacco tins hidden amongst the sage, but is recognizable today since it is the only instance of reasonably flat ground along the Section 1 roadway. A little farther along on the right (south) is a scenic overlook with an interpretive exhibit (probably from the early 1960s) pointing out the regional and nearby geology. Just a little beyond the exhibit, the road curves into the Nevada Switchback at elevation 4600' and the sixth roadway line.

Many motorists stop at the Nevada Switchback and there is much to see at its scenic overlook. Views are to the north and the imposing East Temple, to the east toward the Pine Creek gorge with the Great Arch sweeping upward to the slickrock plateau immediately above, and to the south toward the tunnel cliffs. Good views are obtained of the cliff windows at Galleries 1 and 2, although the excessive concrete and recent slide scars detract from the scene. An informal path leads from the south of the overlook and allows access to segments of the old pioneer trail and the slope beneath the galleries. The upslope of the Nevada Switchback sustained the greatest damage during initial road construction, as successive slides buried vegetation while men excavated to stabilize the slope. It has revegetated nicely, however, and at any rate, cannot be seen from along the road.

The sixth roadway line between Nevada and Spring Bend switchbacks is unremarkable except for the only example of upslope masonry retaining wall along the entire Section 1. The slope and roadway above this line underwent extensive reconstruction in 1932-33 to correct excessive slipping and sinking, and the retaining wall may have been placed at that time. At Spring Bend Switchback (elevation 4760'), the road curves to the left and into the seventh, final line to the west portal at elevation 4835'. This piece of road is cut into the slope immediately below the cliffs and is the first to take the fall of cliff slides. One such slide deposited a 50-ton boulder at the west portal on 8 June 1960, requiring two days of blasting to clear it.[70] Today, a small wooden ranger hut built after the 1960s and of no

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[70] ZNP Superintendent's Monthly Narratives, June 1960, history boxes, ZNP archives.

particular architectural style sits along the scenic overlook at the north (left) side of the roadway, and a nearby ranger controls traffic into the west portal. The square-shaped hut encloses about 35 square feet and is of vertical pine boards with large windows on the east and west sides and a door facing the roadway. Eaves of the shingled hip-roof overhang all four sides. Between the hut and tunnel portal there is a metal gate which can swing out to close the roadway in an emergency.

This entire 3.6 mile segment of road was constructed in 1927-1929 as Section 1 of the Zion-Mount Carmel Highway Project, and has certain common characteristics. First, it was built as a scenic road in the context of the earliest NPS/BPR park roads carved into mountainous terrain, which is to say that it is basically curvilinear with all grades less than 6 percent, tangent grades superelevated to optimum speeds of about 35 miles per hour, and switchback curves with radii and superelevations designed for 20-25 miles per hour. From above or below the roadway, the motorist cannot see adjacent road lines except for retaining walls on downslopes. This has the tendency to keep the motorist's attention on intended scenic vistas and away from the reality of driving along steep downgrades. All slopes are as vegetated as possible through deliberate revegetation efforts and minimal construction damage to present an aesthetically-pleasing landscape as well as fix the steep, slide-prone slopes. All roadside structures--including bridges, retaining walls, guardrails, culverts, and exhibits--are rustic style masonry (except the top ranger hut). The road and scenic overlook pullouts have a wearing course that blends with the surrounding geology--in Zion's case, red-tinted aggregate used in chip-sealing and obtained from pits near the park.

There is no doubt that this section of road retains its integrity to 1930, as considerable trouble was had to make the cuts and build up the embankments to support the current roadway and no other roadway is possible. The park's Chief of Maintenance believes that the road's subgrade, subbase, base course, and wearing course are original, with crack-sealing and chip-sealing applied over the original asphalt over the years. Since this section of road started out as an oil-mixed gravel surface, this opinion, of course, dates to the first time the road was asphalted which appears to have been in the middle 1930s. The author found no information to dispute this belief and numerous references to simple chip-sealing which tend to support it. There are probably small areas along the roadway that have been replaced down to the subgrade due to sinking, slides, or rockfalls, however.

A description of the tunnel segment of the highway is detailed in a related report (HAER No. UT-39-A) and summarized here. The last tangent of Section 1 roadway is cut into the south cliff to provide adequate sighting distance into the tunnel. Motorists enter the symmetrical masonry portal flanked by an asymmetrical masonry facade without the slightest change in grade. Whereas until recent years they could stop at the five magnificent window overlooks, today they are expected to drive through the entire 1.06-mile tunnel nonstop and catch distracting glimpses of the outside as they speed past. Windows and vehicle headlights provide the only tunnel illumination, thus, the visual experience is somewhat dim. Motorists test the structure's acoustics with whoops, hollers, whistles, horns, and occasional gunfire. All in all, the aesthetic experience of a drive through the tunnel is something less than decades past.

The roadway and tunnel lining are very much like they appeared after the 1937 tunnel lining project. The roadway is 20' wide with a wearing course of concrete, and is flanked by one foot curbs. Thus, wall to wall clearance is only 22', and with the size of modern recreational vehicles coupled with five tunnel curves and light sufficient only to foster claustrophobia, it is small wonder that park rangers have to control traffic at each portal.

The roadway emerges from the east portal at elevation 5124' immediately upon Upper Pine Creek Bridge which spans the narrow Pine Creek gorge. This narrows, requiring an approximate 100' span, was initially bridged with a temporary wooden structure in October-November 1928, to move equipment onto Section 3 construction. The Nevada Contracting Company built the permanent 128.5-foot steel I-beam and concrete bridge in April-July 1929, with a 20' roadway, and at a cost of $22,795. This bridge retains its integrity to that year, and consists of five steel I-beams spanning three sets of piers and covered with poured-in-place concrete. The concrete piers and abutments are anchored into the solid rock of the gorge bottom (cellular concrete foundations) and sides. Unstylized solid concrete guardrails line the sides of the bridge roadway.

Immediately across the bridge there is a scenic overlook/ parking lot serving visitors who want to take the short Canyon Overlook Trail west to gain a view of lower Pine Creek Canyon and the highway's switchbacks. There is a simple wooden outhouse at the east side of the lot. A ranger hut sits at the southeast roadside immediately beyond the bridge, a duplicate of the hut at the west portal. A swinging metal gate similar to the one at the west portal is adjacent to the hut on its southwest side and

cannot be swung across the road because it is obstructed by the more recently placed ranger hut.

Upon emerging from the tunnel, the visual experience changes immediately and radically from that of the lower switchbacks. The road is nearly 100 percent curvilinear for the entire 6.1 miles from the tunnel's east portal to the park's east boundary, and winds through the spectacular landscape dominated by "slickrock": rounded, cross-bedded sandstone formations cut by myriad, sinuous, intermittent drainages. The National Park Service, Bureau of Public Roads, and their contractors--Nevada Contracting Company and Raleigh-Lang Construction Company--built the first 3.63 miles east of the tunnel in 1929-30, while the Bureau of Public Roads, Utah Road Commission, and Raleigh-Lang completed the remaining 2.44 miles in 1928-29. Construction differences between the two sections were noted earlier, but today the overall impression is of one beautiful highway piercing some of the most lovely and rugged country in the Southwest.

An example of the attention to detail paid by the NPS is found just 1/10th of a mile east of the tunnel in two corrugated steel culverts, which are faced with masonry despite being buried under tons of fill at the bottom of an embankment and completely unobserved from the roadway. This represents the high aesthetic standard for minor culverts along the road. The masonry culvert which took the contractor so long to build and caused so much extra work in early 1929 redirects the flow of Pine Creek as it joins with Clear Creek another 1/10th of a mile east of the steel culverts. This is a solid masonry keystone arch approximately 8' high, 12' wide and 120' long, and is also (unfortunately) unseen from the roadway. The arch is flanked on the downstream side by a masonry wall about 60' long and 12' high which turns the waters of the joined Clear and Pine creeks away from the roadway embankment. No lovelier culvert exists in Zion National Park. The first of four 9'x9' unlined water tunnels is found at the bottom of the embankment immediately west of the short tunnel. This water tunnel was built in mid-1929 at Station 267, is 136' long--which represents the width of the embankment base at this point--and is representative of the other three water tunnels. It has concrete footers at its south portal.

The short tunnel at elevation 5275' has been recently reconstructed with a safer approach alignment and an enlarged bore. In the summer of 1993 one simply passes through a 480' hole in the rock as the interior had been reamed to bedrock on all sides and the road surface excavated to subgrade. The tangent is straight through the tunnel, and the structure is short enough that it does not require artificial lighting.

Beyond the short tunnel, the roadway continues to weave and climb through the same slickrock formations, trying desperately to stay on the north side of Clear Creek and succeeding as far as the old state highway section at Clear Creek Bridge. Principal construction features to this point are almost constant, alternate cuts and fills, punctuated by roadway blasted into the sides of the slickrock. The grade is always rising toward the east, climbing out of the land of fantastic forms which will not be achieved until the park's east entrance station is reached. The jumbled geology creates numerous microecosystems, such that one cannot tell exactly what life zone he is passing through. Firs and ponderosa pine seem as common as juniper and pinyon pine or mormon tea, scrub oak, and shrubs of the lower desert.

Four-tenths of a mile beyond the short tunnel a scenic overlook on the right side of the road offers a cross-cut view of the country and road which is representative of this entire road building effort. Facing generally north, one looks up the sandy bottom of Clear Creek to the road embankment of near solid rock faced with a long masonry wall running perpendicular to the creek. Above the roadway is an "upslope" of solid, rounded slickrock, the lower 20' of which was blasted to create the roadway. Above this man-made cliff the cross-bedded sandstone mound retreats from the vision and points to a more distant mound untouched by the roadway. Creek, rock, retaining wall, road, cliff, and more rock: the sight is offered at most any point along the highway. Generally unseen are the many corrugated pipe culverts, two masonry arch culverts, and four water tunnels which protect the numerous fill embankments. Far more visible are the numerous notched cuts all along the roadway--in the NPS section as well as the state section of highway.

Perhaps the most remarkable feature of this 6.1-mile section of highway is that the roadbed along the entire way is completely manmade. Not a foot of the road rests on simple graded natural earth, rather, it is all built along fill embankments, cuts in the sandstone, or bridges--right up to the park's east entrance station. The bridges at Clear and Co-op Creeks, previously described, simply carry the road to the south then back to the north of Clear Creek where no other route was possible. There are fewer scenic overlooks astride the road in this section, as the terrain would make each of these a real construction effort, but there are several with roadside exhibits, including the large overlook at Checkerboard Mesa now under reconstruction. The roadway through this bewildering natural maze somehow maintains a gentle grade of less than 4-5 percent for the most part, and the slow speeds required of the curvilinear alignment make these grades almost unnoticeable. The wearing course today is a

uniform, red-tinted, chip seal from tunnel portal to entrance station.

It is entirely possible that when Congress expanded Zion's dimensions in 1930, NPS administrators requested a new eastern boundary at the point where the slickrock maze ends and the plateau begins. The motorist today no sooner rounds a final curve and enters an arrow-straight tangent (for the first time in 11 miles) when he approaches the east entrance checking station at elevation 5560'. The NPS built this small, rustic masonry building with pitched, shingled roof in 1934-35, just after the state gave up its 2.44-mile section of road. Prior to 1934 the park did not keep track of visitors arriving from the east. The station today is visually marred by modern signage, chalk board, and light fixtures on its west eave, but otherwise the exterior maintains its historic integrity. The actual park boundary at elevation 5780' is another .6 miles along the tangent and is marked by the masonry entrance pylons constructed by the CCC and hanging wooden sign. Beyond to the east the road crests atop the slickrock plateau, opening more spacious but hardly more beautiful vistas of southwestern Utah's sandstone country.

SIGNIFICANCE/CONCLUSIONS

Significant aspects of the Zion-Mount Carmel Highway are many and varied. Within the context of tourism, the most significant aspect is the highway's completion of the circle of southwestern Utah parks. Whether this particular road had to be built in this particular place to complete the circle can be debated, but that it did so in the minds of NPS administrators, Union Pacific Railroad officials, Utah State road commissioners, and local business boosters cannot be denied. It also fit perfectly the powerful vision of Stephen T. Mather as another link in the "park-to-park" highway system. Too, as the most recent addition to modern regional roads built to improved standards of 1930, it afforded one of the more pleasant auto touring experiences in the area. Built as a scenic road--presenting unparalleled vistas at every turn, an exciting tunnel from which to peak out, and the fantasy of the slickrock beyond--it was (and is) a touring marvel.

Within the context of historic road building, it fits not only the nascent ideals of the Bureau of Public Roads and National Park Service but also represents one of their earliest cooperative efforts. The two agencies joined to create modern scenic highways in 1925. Two earlier examples of joint construction are found at Mount Rainier and Glacier national

parks, but the BPR's B. J. Finch explored a Zion road route as early as 1923 and R. R. Mitchell located the Zion-Mount Carmel Highway in 1925. From that first location in 1925 to the road's completion in 1930, the effort was a model of BPR location, survey, specification, contract bidding, engineering, and supervision--tempered by the landscape, scenic, and economic concerns of the NPS. Although mistakes were made along the way, they appear minor alongside the splendid result, and although an expensive piece of work at nearly $1.5 million for 8.5 miles of roadway, the final cost came in with only a $5,000 variance from the earliest estimates.

Within a final context of engineering, the difficulties overcome, certain methods used, and results achieved represent firsts in the profession or world records of the time. These have been discussed within the text, but summarily they include locating and surveying virtually inaccessible terrain; boring a tunnel completely from the inside out and ring-drilling to achieve the main bore of an automotive tunnel; and constructing the longest automotive tunnel in the national park system and the longest in the western United States in the year of its completion.

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ADDENDUM TO
ZION-MOUNT CARMEL HIGHWAY
Zion National Park Roads and Bridges
Between North fork Virgin River and east park boundary
Springdale Vicinity
Washington County
[redacted] Utah

HAER NO. UT-39

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